# The JOURNAL of ELECTRICITY POWER AND GAS

WITH WHICH IS INCORPORATED

The Engineers', Architects' and Builders' News

PUBLISHED WEEKLY

By the Technical Publishing Company, Atlas Building, 604 Mission Street, San Francisco Cal.
Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879.

Vol. XVIII. No. 13 San Francisco, Cal., March 30, 1907. Yearly subscription $2.50 Single copies 10 cents Back numbers prior to current month 25 cents.



OKONITE WIRE

*The Standard for Rubber Insulation*

Okonite Tape, Manson Tape,
Candee Weather-proof Wire,
Candee (Patented) Potheads.

THE OKONITE COMPANY, 253 BROADWAY, N. Y.

STANDARD UNDERGROUND CABLE CO.

MANUFACTURERS OF

BARE AND INSULATED WIRES AND CABLES

CHICAGO PITTSBURG PHILADELPHIA ATLANTA
NEW YORK BOSTON ST. LOUIS SAN FRANCISCO
LOS ANGELES OAKLAND SEATTLE

PACIFIC COAST DEPT. A. B. SAURMAN Pacific Coast Mgr. BACON BLOCK, OAKLAND, CAL.

Meese & Gottfried Company

19th and Harrison Sts., SAN FRANCISCO

Power Transmitting Machinery

Of all description. We have a larger stock of Shafting, Hangers, Boxes, Pulleys, etc., than ever.

*Seattle* *San Francisco* *Los Angeles*

VULCAN

Refrigerating and Ice Making Machinery

Manufactured by

Vulcan Iron Works, Cor. Kearny and Francisco Streets, San Francisco

INDIANA RUBBER AND INSULATED WIRE CO.

MANUFACTURERS OF

PARANITE AND PEERLESS RUBBER COVERED WIRES AND CABLES

Underground, Aerial, Submarine and Inside Use
TELEPHONE, TELEGRAPH AND FIRE ALARM CABLES

All Wires are Tested at Factory JONESBORO, IND.

ELECTRIC APPLIANCE CO.

315 Main St., San Francisco Pacific Coast Agents

San Francisco Los Angeles Oakland

HENSHAW, BULKLEY & CO.

Exclusive Agents Ames Engines and Boilers

219-221 Spear St. San Francisco, Cal.

Bristol's Recorders

For Every Electric Light
Railway, Power and Gas Plant Compel

Safe and Efficient Operation

Send for Catalogue A. V.

The Bristol Co., Waterbury, Conn.

N. Y., 114 Liberty St. Chicago, 753 Monadnock Block.

The National Conduit & Cable Co.

Manufacturers of

TROLLEY WIRE
BARE COPPER WIRE AND CABLES
WEATHERPROOF WIRES AND CABLES
PAPER-INSULATED CABLES
FOR TELEPHONE, TELEGRAPH AND POWER

703 MONADNOCK BUILDING, SAN FRANCISCO

C. H. PENNOYER, PACIFIC COAST MANAGER

BROOKS-FOLLIS ELECTRIC CORP.

Electrical Supplies of all Kinds in Stock

214 FIRST STREET, Cor. Tehama SAN FRANCISCO

OAKLAND, 563 13th Street

PACIFIC METER CO.

MANUFACTURERS OF

WET AND DRY GAS METERS, STATION METERS, PROVER'S GAUGES, ETC.

917 AND 918 MONADNOCK BUILDING. SAN FRANCISCO, CAL

VAN EMON ELEVATOR CO.

MANUFACTURERS OF .... HIGH-GRADE ELEVATORS

R. J. DAVIS, President
B. C. VAN EMON, Vice-President and Manager
H. B. RATHBONE, Secretary and Treasurer

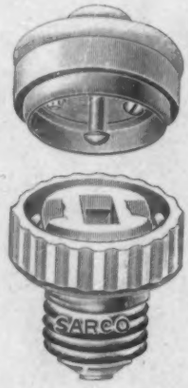
NOT IN THE ELEVATOR TRUST

DIRECTORS
LOUIS F. MONTEAGLE W. P. PLUMMER
GEO. M. PINCKARD R. S. HUNKINS

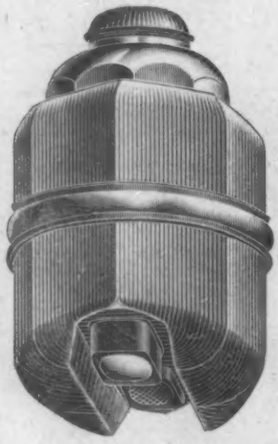
OFFICE AND CONSTRUCTION DEPARTMENT
52 - 54 NATOMA STREET, SAN FRANCISCO

FACTORY AND FOUNDRY
WEST BERKELEY, CAL. (32,000 sq.ft.)

Two Plug in One




Separated
Separable and Swivel



10 Amp. Pendant Switch
Double Bushing, Takes Both Code and Reinforced Cord

# SEE OUR PRICES

We specialize on every new and useful article gotten out for the Electrical industries.

## Factory

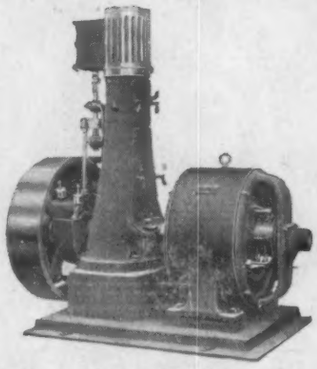
managers know this and place us as their Pacific Coast Agents with large stocks to draw from. Our

## Delivery

is therefore immediate and our prices cannot be duplicated

## On the Coast

All those interested in electrical machinery, supplies and construction, who write for bulletin on appliances which interest them will receive from us the handiest device yet gotton out FREE.



Generating Sets

Century A. C. Motors

Long Distance and Intercommutating Telephones

# STANDARD ELECTRICAL WORKS

58 & 60 Natoma Street  Phone, Temporary 894  SAN FRANCISCO, CAL.

THE

# Journal of Electricity, Power and Gas

WITH WHICH IS INCORPORATED

The Engineers' Architects' and Builders' News

VOLUME XVIII. SAN FRANCISCO, CAL., MARCH 30, 1907 No. 13

## The Restoration of Telephone Service in San Francisco

Just previous to the disastrous fire which swept over San Francisco after the earthquake of April 18, 1906, the Pacific States Telephone and Telegraph Company had in use in that city about 52,000 telephones which were served from eight exchanges located in various parts of the city. The Main, Mission, South and Chinatown exchanges were totally destroyed, as well as the equipment in the East exchange building, which, being of class "A" construction, withstood the intense heat, although the contents were entirely destroyed. These five exchanges served about 38,000 telephones, and the loss of their equipment greatly complicated the work of restoring telephone communication.

Practically all the improvements which the Telephone Company had made, or had partly completed, during the preceding five years in expanding and modernizing it system to keep in pace with the growing demands of the city, were reduced to heaps of ruins. The East exchange, previously mentioned, which is at 821 Hyde Street, had been in use just about a year. The switchboard was equipped for 8,000 stations with an ultimate capacity of 18,000 stations.

A TELEPHONE EXCHANGE IN CHINATOWN PREVIOUS TO THE FIRE.

In addition to the exchanges in use at the time, a three-story brick building had just been completed at West Mission and Herman Streets, and a multiple switchboard, equipped

for 20,000 stations with an ultimate capacity of 40,000, had already been installed. This new exchange was to be opened on May 1st, 1906; the telephones served from the South, Mission and Park exchanges were to be operated from this one, which was to be known as the Market Exchange. The fire penetrated the upper floors of the building and completely destroyed the switchboard, though part of the remaining equipment was saved and used for refitting the exchange.

East Exchange Building, 821 Hyde Street, as it stands to-day, completely restored and serving 4,000 telephones.

A new eight-story, class "A" building had been erected at 445 Bush Street, and considerable work had been done on the installation of a new multiple switchboard for local service and a toll board for the accommodation of the long-distance lines. This exchange was to constitute the Main exchange, and was to have taken the place of the old "Main" exchange in the six-story brick building located at 216 Bush Street, which was destroyed in the fire. Had normal conditions prevailed this exchange would have been ready for service in July, 1906. The multiple board was equipped to accommodate 30,000 telephones, with an ultimate capacity for 50,000. The toll board was equipped for the control of 150 long-distance lines. The building itself withstood the ravages of the fire, but the contents were a total loss.

Market Exchange Building, West Mission and Hermann Streets, restored since the fire. This building, with switchboard equipment, was to be ready for service May 1st, 1906. The fire penetrated the top floor and consumed the switchboard. The switchboard installed in this building since the fire is serving 5,000 telephones.

Executive Building, 140 New Montgomery Street, completed in February, 1906, and occupied but two months prior to the fire. This building a total loss by fire.

The new four-story brick building at 140 New Montgomery Street, in which the executive offices of the company had been located since the preceding February, was burned to the ground.

Those exchanges, which were untouched by the fire and on which the burden of supplying the much-needed telephone service fell, were the West exchange, at the corner of Pine

New "Main" Exchange Building, 445 Bush Street, as it stands to-day and restored since the fire. This building was completed just before the fire, but not occupied. The switchboard equipment being installed at the time of the fire was a total loss.

and Steiner Streets, and the Park exchange, on Page Street. The Butchertown exchange, at the corner of First and Railroad Avenues, was also saved, but on account of its size and location was of little importance. The West exchange was only partly completed, and was limited in the number of subscribers it could serve. The Park exchange was a small one, and was to have been abandoned when the new Market exchange was to be opened, as before mentioned.

With the overhead wires in the burned district entirely gone and those in the unburned district broken and tangled, snapped by the force of the earthquake or cut down in clearing the trolley wires for the operation of the street engines, the service which the company was able to give during the first few days after the fire was necessarily greatly limited. A large force of men was employed to place distributing poles throughout the burned district at points where the underground cables could be tapped, as before the fire they had distributed into the various buildings through cables running into the basements.

The Citizens' and Relief Committees were the first to receive consideration from the Telephone Company, and steps were immediately taken to install telephones for their use. The telephone stations at the Ferry Building received immediate attention so that there was connection at all

A PICTURESQUE INTERIOR IN CHINATOWN. THE CHINESE ARE CONSTANT USERS OF THE TELEPHONE.

cars, and with the supply of electric power cut off, the problem of restoring telephone connections was not an easy one. Fortunately the underground systems were but slightly damaged, and steps were immediately taken to get them ready for use. In the meanwhile switchboards and other apparatus were ordered by telegraph to be shipped immediately by express.

Steps were taken at once to prepare the West and Park exchanges for service. Gasoline engines were employed to drive the generators for supplying current for charging the storage batteries. On account of the small capacity of these times from this place to Oakland.

On April 28th, seven days after the fire had ceased to burn, the first telephone list was printed. It contained the numbers of thirty telephones which had been connected for the accommodation of the various relief committees, the hospitals, newspaper offices, the Board of Public Works and other branches of the city government.

With the gradual resumption of business and its transfer to congested sections of the unburned district where the systems of distribution had not been designed for such an emergency, the entire redistribution of the underground ca-

bles was necessary. Many hundreds of feet of cable had to be pulled through the conduit and spliced up. Since these cables carried from 50 to 400 pairs of wires, the splicing required considerable time and care, as each wire must be properly paired throughout the entire length of the cable. A large force of men was employed to clean up enough space on the lower floors of the buildings at 445 Bush Street, 821 Hyde Street, and that at the corner of West Mission and Hermann Streets to serve as temporary quarters for the switchboards ordered by express. Additions were made to the switchboards at the West and Park exchanges as soon as the necessary equipment could be obtained. Much of the work had to be done at night by the light of candles and

CONDITIONS UNDER WHICH OPERATORS WORKED JUST AFTER FIRE.

lanterns, and it was necessary to establish commissary departments for the benefit of the workmen.

On May 12th, less than one month after the fire, the first telephone directory in book form was issued. It contained the names of 2,880 subscribers, all of whom received connections through the Park, West and Butchertown exchanges. On May 23rd the new Main exchange at 445 Bush Street was opened, and on June 9th the new Market exchange at West Mission and Hermann Streets was ready for service. The equipment in both of these exchanges is, however, only temporary. On September 15th the new Franklin exchange

West Exchange Building as it stands to-day. This exchange, located outside of the fire line, was not damaged, and was one of the two exchanges intact after the fire. It has been doubled in size since the fire, to meet the growth of that district.

was put into service with a permanent equipment.

The following figures are significant of the progress made during the past eleven months in meeting the demand for telephone service in San Francisco:

| | | | | | | |
|---|---|---|---|---|---|---|
| Telephones in use | two | months | after | the | fire..... | 9,071 |
| " " " | three | " | " | " | " ..... | 10,975 |
| " " " | six | " | " | " | " ..... | 18,270 |
| " " " | eleven | " | " | " | " ..... | 27,537 |

This is a creditable showing, in view of the great difficulties of obtaining the necessary equipment and labor, and is an excellent indication of the rapid restoration of normal conditions in San Francisco.

The work of building and equipping the new permanent exchanges is progressing rapidly. It is expected that all of these will be ready for service before the end of the current year.

## SMALL ELECTRICAL DEVICES NEED CONSIDERATION.

A recent disastrous fire—disastrous in that it caused the destruction of a magnificent home—was caused, it is said, by the negligence of a servant using an electric flat-iron. Whether this statement is true or not is immaterial, but in view of the charge, the "Electrical Review" points out that small electrical household devices need a certain amount of consideration. This statement is true of any utensil in which heat is developed, but the public seems to think that because it sees no flame there is no possibility of fire. No servant, however thoughtless, would throw a towel around a lighted gas lamp; yet how many appreciate the possibility of a fire if the same treatment be applied to an incandescent lamp? It is not realized that an incandescent lamp, although it gives out considerably less heat than an oil or gas lamp when giving the same amount of light, still does set free heat in large quantities; in fact, the amount of heat given out by an incandescent lamp is equivalent to about one-twelfth of a horsepower. This statement will not convey much meaning to the uninitiated, though perhaps it may be impressive, but a more impressive way of illustrating the point is to wrap a towel around an incandescent lamp and see what happens. When the heat is thus confined, it will not only set fire to the wrapping, but may soften and melt the glass bulb. This fact is well known, and the insurance rules provide for it. In one sense of the word it constitutes a danger, but the risk from this source is comparatively small, since it is not customary to hang clothing on electric lamps; it is practically negligible in all properly-cared-for homes.

This is true of the incandescent lamp, and is true of any heating device. A curling iron, if left in circuit and wrapped up, a chafing dish, if completely enclosed, or a flat-iron, if left in circuit upon inflammable material, may start a fire. It is the function of the electric current to develop heat in the flat-iron. The amount of heat thus developed must be considerable, as in the process of ironing, a good deal of water must be converted into steam. If the heater be left in action, but the iron be placed so that it cannot get rid of this heat, the temperature must necessarily rise. It is possible to obtain some degree of protection against fire in such cases by introducing a thermostat in the heater, but this does not entirely obviate the danger of fire. Also, it is easy to arrange the iron so that the electric current will be cut off whenever it is released from the hand; but here again there is a possibility that the automatic switch may get out of order. The only sensible thing to do is never to leave the iron in a position where it can start a fire. In general, the danger is slight, but it should nevertheless be realized.

There are many other little electrical devices which are exceedingly safe when compared with other apparatus for performing the same operations, but it should never for a moment be forgotten that an electrical current represents energy; that all forms of energy tend to become heat, and that heat, if confined, may start a fire. Electrical apparatus as a class introduces less danger than any other, but it may become dangerous if abused.

## LITERARY ENGINEERING.*

By George A. Wardlaw.

It is our purpose to consider only one of the many aspects of engineering activity, the aspect that finds expression in what is rather vaguely phrased as technical literature. In rather marked contrast to the fine imaginative qualities—the daring, the cunning, the patience shown by the engineer in conceiving, designing, constructing, and operating apparatus, is the lack of literary imagination indicated by the dearth of clear and forceful expression in what we have agreed to call technical literature. As revealed in technical literature, the style shows that the engineer is strangly indifferent to the codes of grammar, rhetoric, and idiom established by recognized good use. While his engineering conception and execution are virile, his literary expression is unmistakably weak. The elements and qualities of style are more or less ignored, forgotten in the prevailing tendency to sacrifice everything to what is quaintly phrased as "doing things." So intently does the engineer pursue this commercial siren that he has neither time nor temper to bother with mere verbal expression. As a scribe he is frequently found doing things that smack of engineering heresy, or that indicate a limited conception of the idea embodied in the mystic word, efficiency. More often than not his literary expression of engineering activity is so peculiar that the proverbial editorial blue pencil is also kept busy "doing things" in the effort to produce efficiency by harmonizing the literary expression with the engineering facts. If there is one word that engineers harp on it is the word "efficiency." Efficiency is the engineer's ultimate test of the worth of any piece of apparatus; inefficiency is its death-knell. As we shall show later, this is equally true of all technical composition, whether the composition be a machine or a descriptive article.

If, then, we are to give literary expression to engineering activity we should be willing and anxious to make this expression conform to the writer's art, the art of putting sound sense in pure language. This art is long and arduous, but it is worth all that it costs in time and labor. The acquiring of it reduces the likelihood of misunderstandings; with fewer misunderstandings we shall have fewer quarrels and lawsuits, and the fewer the quarrels and lawsuits the more our efforts will make for efficiency and happiness. In literary work, efficiency and happiness can be approached, indefinitely at least, by a judicious application of the principles governing the elements and qualities of English composition; these principles can be acquired by absorbing the substance of any good text-book of rhetoric, and their application can be found in the works of the masters—the classics. Occasionally there arises a genius whose activities, engineering and literary alike, refuse to be curbed by ordinary methods; whose literary expression is regulated, not by the principles of composition, but by a sort of divine inspiration. But as most of us are ordinary grubbing mortals with commonplace talents, it were best perhaps, in giving literary expression to engineering activity, to follow, not the vagaries of the soaring genius, but the dictates of common sense and the mandates of good use. In clearness lies our strength; in vagueness, ambiguity, or obscurity lies our weakness, a weakness that indubitably tends to retard the attainment of the professional dignity and recognition to which we are entitled equally with the physician and the lawyer.

This problem of clear expression in technical literature is not a mere academic one; it is one of the most practical problems with which the engineer has to deal. Lacking clearness a specification might result in professional and financial ruin to the unwitting and unfortunate author or client. While deciphering a vague or obscure passage, important work might be irretrievably delayed. Owing to the scarcity of the mental lubricant, lucidity, there is much needless friction, resulting in the loss of time, energy, aand perhaps money. In short, as a literary machine the non-lubricated engineer would prove inefficient and detrimental to the best interests of his client. It has been well said that he who can express his thought readily and clearly can usually command what he wants.

So urgent is the need of better literary expression among engineers, that at the last annual convention of the American Society of Civil Engineers, Mr. Bernard R. Green is reported as expressing the following views on this vital subject: "Engineering literature, descriptive or critical, of undertakings or accomplished works, or of the experiences of difficult construction, is thin and scarce. Engineers have not written enough, do not write well enough, and do not like to write because they do not know how. This is because of the insufficient training of the past generation that prevented ease and fluency in writing by one intensely engaged in practical work. Consequently, many valuable experiences and ingenious accomplishments, which might have been invaluable to others and to the world, have lived and died in the minds and memories of the engineer geniuses, to whom the labor of concise and readable records was irksome and laborious."

Clearness of expression, then, setting aside for the moment the other and higher qualities of style, has but little charm for the engineer. Clearness is for the nursery. The Philistines tell us that what the engineer wants is forceful expression and plenty of it. This is the quality of style that best interprets engineering activity. Did the engineer but know it, clearness is infinitely easier of attainment than force; for force requires exact diction and extreme brevity—it is attained, not by the use of many words, but by striking out the needless words and phrases, and then deliberately weakening the intensely vigorous passages. In short, force is rarely attained; and clearness of expression—using the right word in the right place—it seems, varies inversely as the complexity of the subject. The long involved sentence is one of the characteristics of an engineer-author.

This state of affairs is unfortunate, unfortunate for the engineer-author and the reader alike, for it tends to confuse and bewilder the reader while it reflects seriously on the quality and breadth of the engineer's mind. His facile technical mind is not only poorly reflected but also frequently distorted when mirrored by manuscript or type. Among editors and proof-readers he is ever on the defensive, and the members of the so-called learned professions look at him askance. This attitude reached its climax several years ago when an eminent individual in addressing one of the national engineering societies, advised its members not to join in a laborers' strike. Where that eminent individual got his notions is hardly pertinent to this talk; the incident is cited here merely to show how we are thought of by other professional men, even though we may assume a top-lofty attitude and pity their ignorance of present-day intellectual development in the scientific world. Maybe that eminent individual's notions regarding the lack of culture in the engineering profession, and consequently the engineer's social status, were induced by the reading of a few unedited manuscripts!

### Words.

So much for this interesting subject in perspective; now let us consider it somewhat in detail. We have said that many of the literary expressions of engineering activity are inefficient because the quality of force is rarely attained, and that of clearness seems to vary inversely as the complexity of the subject. Clearness, we agreed, is attained by using the right word in the right place, and force by using the fewest words that the subject will bear. Much of the literary expression of engineering activity errs in these particulars simply because the engineer is so rich in ideas and so poor in words that he finds it hard fully to express the one in the other. The ideas are so many and the clothes so few that his best thoughts frequently masquerade in misfits or motley, and sometimes they are so adroitly masked that even the author

*Abstract from a lecture delivered before the engineering students at Cornell University.

fails, after a brief lapse of time, to recognize the products of his mind.

Subjecting the literary express of engineering activity to a cursory examination, we find our authors taking strange liberties with the language, with the code of good use as recorded in the grammars and dictionaries. It were needless to multiply examples of engineering solecisms; a few taken at random from manuscripts written by practicing engineers will serve our purpose. Singular subjects, we find, are often coupled with plural predicates, and singular predicates with plural subjects. "Data is," "data was," "this phenomena," "each of these types have," "none of the machines have"—all these occur frequently in literary engineering. The past and present tenses are often confused, and shifting from the active to the passive voice is not uncommon. More common still is the shifting in the same sentence from one person to another, as will be seen in the following utterance: "I say, if you want to standardize. you might as well stay where we are now and use what is here and what is known to be reliable rather than go to new types as recommended by them."

Splitting the infinitive is another favorite pastime, for we find almost endless repetitions of phrases like: "To materially affect," "to fully meet," "to clearly state." It would be well, perhaps, to amend literary engineering in this particular, for among the discerning the split infinite bears the same relation to literature that lack of consideration does to social behavior. Fewer split infinitives would no doubt better the English without hurting the engineering.

As long ago as 1817, Cobbett wrote to his son, saying: "The word 'it' is the greatest troubler that I know of in language. It is so small and so convenient that few are careful enough in using it. Writers seldom spare this word. Whenever they are at a loss for either a nominative or an objective to their sentence, they, without any kind of ceremony, clap in an 'it.'" The troubler is still doing business at the same old stand, and his kinsfolk, "their," "they," "them," have been taken into the firm. These pronouns are a prolific source of ambiguity: "By the arrangement shown," we read, "the centre of gravity will be low, and it leaves a compartment at one end." Here the grammatical antecedent of "it" is "centre of gravity," and to write in this way of the centre of gravity is to write nonsense. The centre of gravity is not yet an active verb. "Iron poles," we read in another place, "are to be avoided principally on account of danger to linemen and their short life due to rusting." This unique statement reminds us of the famous sign over the London bootblacks' stall, "English spoken; American understood." We understand of course that the poles do the rusting, even though the writer tempts us to believe the linemen guilty of it. Again we read, "The results secured from the machines are different every time they are thrown together." Here the writer means to say that the results are different every time the machines are thrown together, not that the results are different every time the results are thrown together, for the latter statement means nothing at all.

Occasionally we find a misplaced adjective distorting the author's meaning, but this offense is comparatively rare in literary engineering. Misplaced adjectives, though offending against clearness, are not dangerous, as we can usually guess the author's meaning. "In America," we read, "the underground electric cable manufacturing companies have refrained from publishing experimental data relative to cables." As the cable manufacturing companies are still above ground, this writer would have avoided ambiguity by recasting this sentence, so as to make it say what he means. He means to say that, "In America, the companies manufacturing underground electric cables have refrained, etc."

These few examples will suffice to show the engineer's scorn for mere grammar. His indifference to diction, though not quite so apparent, is more liable to misrepresent his thought. Paucity of vocabulary is, no doubt, responsible for many constructions that result, sometimes in ambiguity, sometimes in obscurity, sometimes in arrant nonsense. The use of "partial" for "part" in the sentence, "Partial reports were secured from other plants," is ambiguous, because it can be taken to mean reports that were not impartial. What the writer means is "part" reports, reports not complete. "Partial reports were secured for other plants," brings another matter to the surface, the matter of the use of the word secure as a verb. Though sanctioned by grammar, this verb and the participles "securing," "secured," are worked to death by engineer-authors. Nothing is obtained or got in literary engineering, everything is secured, as in the ambiguous sentence, "The readiness with which these plugs can be secured in any location." Other overworked words are eliminate, absolute, system, type, however, and, and our old friend, efficiency. Trifling with words, a well-known engineer makes this unique statement: "Considering the need for the better railway transportation as a solution of the traffic problem it follows, etc." The query arises here, when does the need of a thing solve the problem of getting it? Paucity of vocabulary, resulting in the use of general instead of specific words, is at the bottom of the following statement: "The problem is very much more difficult, due to the necessity of considering in the solution of an engineering problem not the particular problem alone, but in its relation to everything else that exists." We read elsewhere: "But in the past few years electricity has come steadily into use as a means of transmitting the operating power, until at the present time it is the prime element in signaling." Analyzing this sentence from the viewpoint of the engineer, we find it to say this: But in the past few years a form of energy has come steadily into use as a means of transmitting the operating rate of the expenditure of energy, until at the present time it is the prime element in signaling. This is sheer nonsense, caused by a careless use of rigid technical terms. At college we were at great pains to learn that energy is one thing, work still another, and power something that involves not only energy and work but also a time-element. We learned, in short, that work requires the expenditure of energy, and that power is the rate of doing work. Applying these rigid definitions to the words used in the statement quoted above, we find as already noted, a fine example of technical gammon. This use of general words where ample of technical gammon. This use of general words where the thought requires them to be specific is intensely human; we hate to be pinned down to facts; we shun precisions and schoolmarm diction as a pest and a bore.

We have considered this element of words long enough to realize that many of the faults in the literary expression of engineering activity are due to two things; inapt diction and grammatical heresy. Grammatical heresy, we admitted some time ago, to be due to the temperament and environment of our engineer-authors; inapt diction we believe is caused chiefly by paucity of vocabulary. This paucity of vocabulary, as we have said, is unfortunate; for it sometimes causes the engineer-author to array his best thoughts in motley. Careful reading of the classics will help materially to overcome both defects, for the classics are classics only because they put sound thoughts in pure language. Here the elements and qualities of style are handled with great delicacy of touch; the masters are at work painting word-pictures of rare merit; the right word is in the right place; there is harmony between verb and noun; pronouns are not uncertain about their antecedents; and the "lid" is on the split infinitive. There is clearness and force and efficiency. Prose classics for grammatical purity, then; poetry for clear and forceful diction; both alike for rhetorical beauty and literary efficiency.

### Phrases.

It is perhaps too early to look for the engineering bard that can put in simple phrase the philosophy of engineering activity. Kipling's prayer—"God send a man like Bobby Burns to sing the song o' steam," is not yet answered. It may be answered some day; some day when the complexities of engineering activity and the inaccuracies of its literary expression are reincarnated in a holiday edition of power-house

lyrics and transmission line sonnets phrased in simple Saxon. Meanwhile we must be patient and gracious while our engineer-authors coin phrases that ill compare with those in Holy Writ and the other classics, phrases that fall far short of expressing the glory of the other side of the engineer's creative genius, for none but a master of phrase can do that genius justice.

In the absence of a master we find the literary expression of engineering activity abundantly supplied with phrases like these:

Along these lines.
In this connection.
Owing to the fact that.
On the one hand; on the other hand.
This is very significant.
Right here I want to say.
In addition to.
Amount of energy involved.
Which due to its.
Which due to this.
Which due to that.
It should be noted.
Referring to the point brought out by.
Mention is made of the fact.
Look into the question of.
Strike a balance.
Within the scope of.
That is to say.
In other words.

These phrases are in wide general use among our engineering men of letters. They are the fundamental tones in the engineer's organ of literary expression, the overtones taking the form of specific pet phrases that appear more or less frequently in all his compositions.

Two more phrases and we are done with this portion of our subject. During the last ten years probably two hundred engineers have said that the old guesswork species of engineering has been superseded by scientific engineering, phrasing their thought in this wise: "The slide-rule supersedes the rule of thumb." This expression is now a commonplace in technical literature, and should not be dragged from its well-earned obscurity and exhibited as a newly-discovered truth. Like the other phrases we have just considered, it is somewhat hackneyed, and cries to be allowed to dwell in peace. It is an old story now, and like other old stories its piquancy is gone.

By way of offsetting the professional cant phrases that we persist in reiterating, the layman persists in asserting that electricity is in its infancy. In its infancy, indeed! In this country electricity outgrew swaddling clothes years ago, shortly after the introduction of the duplex telegraph; it reached the hobbledehoy period during the development of the incandescent lamp; it arrived at young manhood during the development and application of the electric motor and the telephone. With the application of electricity to the New York terminals of the big trunk-line railroads, our infant will have attained the strength and the dignity of a full-grown man. The layman confuses the work with the word. If any aspect of engineering activity is in its infancy it is the literary aspect. The puerility of this aspect—the very thing we are considering—affirms that it is not practical engineering but its literary expression that has not yet arrived at maturity.

### Sentences.

Efficiency is the ratio of result to effort. If after a reasonable amount of mental effort an intelligent and educated person be unable to detect an author's meaning, then the composition may be said to be inefficient. We have seen that inapt diction is the cause of some of the existing confusion in the literary expression of engineering activity. General phrases we have proved to be somewhat of a dead lift, in that failing to sharpen and vivify the thought they merely encumber the expression with useless words. Some other phrases in general use add nothing to engineering knowledge, because, as admitted commonplaces, they merely—"say'st an undisputed thing in such a solemn way."

Having seen some of the results caused by indifference to the use of words and phrases, now let us look into the engineer's attitude regarding the use of sentences. We have asserted that many engineers frame sentences in vague or ambiguous or obscure language, sentences that are not intended to mean what they say, and sometimes don't say what they mean.

We are told that there is a close relationship between clear thought and clear expression; clear thinking, it is commonly asserted, must precede clear expression. True. But this is not all. Clear thinking doesn't produce clear expression any more than a clear track is a guarantee of the safe arrival of a train. Inapt diction or faulty syntax will ditch a train of thought just as quickly as a broken axle will ditch a train of cars. No matter how well informed an engineer is on his special branch of engineering activity, no matter how clearly he thinks about his subject, he may still fail ignominiously when he tries to express his thoughts in writing. In a public engineering paper—a contract, a specification, for instance—inapt diction or faulty collocation is as menacing to all concerned as a misplaced switch or an open draw-bridge is to a fast-moving railway train.

It has been well said that in no language of culture is the order of words of such high importance as in English, from its having lost almost all of its inflections, or suffixes expressive of relation. A recognized authority on literary good use, Professor Barrett Wendell of Harvard University, informs us that theoretically every sentence should have unity, coherence, and mass. It should treat of one thing at a time; the parts should cohere, stick together; and the parts should be massed so as to have principal and subordinate features properly placed. For the present we shall overlook the quality of mass; unity and coherence are the only qualities that we shall find immediate use for. The text-books tell us to join matters that belong to the same thought; to separate those that are distinct. This is the principle of unity, the most important principle in English composition. It is the violating of this principle, the trying to say too many things at the same time, that causes no end of trouble in sentence structure. When this principle is violated the composition is loaded with "ands" and "buts," resulting in a loose, rambling sort of style that says a great many things, but nothing quite clearly.

This is often the style of the scribe who would fain elucidate some abstruse problem in alternating-current work. His thought may be clear, but his expression is so crude that by and by we are in a hopeless jumble of electrical facts, mechanical or hydraulic analogies, "ands," and pronouns with doubtful antecedents. Here is a case in point. We read: "Considering an electric current to be represented by an elastic fluid, flowing under pressure in a pipe, an inductance is well represented by a fluid motor carrying a heavy fly-wheel. On suddenly starting a direct current through the line carrying such an inductance"—such an inductance is specific and the only inductance specified here is the fluid motor—"the current will have some trouble in establishing itself until the wheel"—here the author has the current and the wheel somewhat confused—"is well under way, after which it will proceed hindered only by the friction or resistance of the apparatus." Here we have the analogy mixed up with one of the properties of an alternating-current circuit, and later we are confronted by an "it" that leaves us in doubt as to whether the author intends the wheel or the current to go on its way.

The following sentences possess unity—each one dwells on only one thing—but the absense of coherence, the faulty collocation, leaves us uncertain whether the authors mean just what they say or something entirely different. The chief engineer of a large electric railway company says: "I will not have men who have not had a college training at the head of any department." This is nonsense; college training

is not usually obtained at "the head of any department." A slight transposition of words is all that it needed to make our chief engineer's expression consonant with his thought. A prominent western engineer says this: "It would be interesting to learn the experience of members of the profession with greased trolley wires." This needs no comment. Again we read: "The writer has been advocating multiple-conductor cables for arc circuits instead of several cables in the same duct in trunk lines for a number of years." In this case we know what the writer means because we happen to be familiar with the subject, but several transpositions must be made before the word truly represents the facts.

We find lack of both unity and coherence to be responsible for the following bit of nonsense: "Various formulas have been given heretofore for the determination of the leakage coefficient of induction motors, all of which differ, however, widely from each other in the results derived therefrom." We turn this into sense; first, by preserving the unity; we insert a full stop instead of a comma after "motors." Then we transpose the second sentence to read as follows: "The results derived from these formulas, however, differ widely from one another." Taking the following classic utterance in order, we find the first vague; the second half vague, half obscure; the third flagrantly violating in one sentence all the principles and qualities of literary good use. To quote Professor Barrett Wendell: "It would be hard to find in equal space a better example of obscurity."

1. "It would take more kilowatts in the short circuit on its alternating side to make the motor-generator run away than the converter."

2. "While none of us can tell with any degree of accuracy, what the ultimate growth of the transformer will be, the speaker thinks we are in better condition to-day to form conclusions than was the case 12 years ago in regard to the transformer as it is at the present time."

3. "The complexities which will be introduced by multiplying the output and voltage of the induction coil are such that the distinction between the magneto and the largest generator in the world will not be found an ill-advised simile for the difference between the simplest form of transformer and the large high voltage units which are now being designed and made."

### Figures of Speech.

There are two kinds of men that use figures of speech correctly and effectively, the untutored savage and the highly trained artist. The artist knows the insidious wiles of mixed metaphor, and seeks deliberately to avoid them. He knows the penalty of kaleidoscopic literary effects. The life of the untutored savage is simple; he has but few wants and uses but few words to express his thoughts. Intuitively avoiding mental complexities, he illustrates his thought by a grunt, a shake of the head, a wave of the hand, or a few short words that suggest something altogether trite and homely. His figures are so few that it is almost impossible to mix them.

As most of us are neither savage nor artist, the chances are largely against our making rational mental pictures, so the fewer figures we use perhaps the more lucid our expression will be. At any rate we would not be telling lies, as it is a truism that a mixed metaphor is at least an unconscious lie. It is attempting to depict something that we know does not exist.

Occasionally our engineer-authors venture into this field of literary endeavor, but not often; the subject of engineering activity is almost too prosaic. The proper place for figurative language is in poetry, and, as we have already said, engineering activity has not yet found expression in a holiday edition of power house lyrics. When engineers do venture into this field they produce some startling effects, tragic or comic according to the humor of the reader. Here for instance is the sentence we considered together some time ago. "The complexities which will be introduced by multiplying the output and voltage of the induction coil are such that the distinction between the magnets and the largest generator in the world will not be found an ill-advised simile for the difference between the simplest form of transformer and the large high voltage units which are now being designed and made." Here we find that the complexities introduced by multiplying two things are such that the distinction between two other things will not be found an ill-advised simile for the difference between two more things. Just what this simile is some of us would no doubt like to ascertain.

A doctor of philosophy writes: "The thin edge of the wedge of competition that has been inserted, has served to awaken considerable dormant energy, the fruit of which cannot be estimated."

A well known operating engineer has this to say about a piece of protective apparatus: "It was thought that the keynote of this situation laid in the development of a time-limit relay."

Here, laid is the past participle of the active transitive verb to lay. What this musical metaphor is capable of laying is beyond comprehension, unless it be other keynotes—a brood of keynotes that may eventually result in a grand electrical symphony.

An eminent engineer in speaking of the pole-line construction of high-tension transmission line says: "The set of downwardly projecting fingers about half way up the pole forms a sort of cow-catcher to prevent people climbing the pole." This suggests one or both of two things; first, that cows are wont to climb poles; and secondly, that people are cattle.

### Conclusion.

This contrast between engineering activity and its literary expression is not caused by inherent incompatibility of temper, for efficiency can be attained in the one as readily as in the other, and by much the same means. All engineering authorities affirm that to produce an efficient machine we must plan and build in accordance with well-established engineering principles. Having completed the plan we select the materials and put them together in a more or less arbitrary way—all the details of planning, selecting and building, being so adjusted as to produce a useful and economical contrivance. All literary authorities affirm that to produce an efficient composition, we must plan and build in accordance with the dicta of literary good use. Having completed the plan, we select the words, arrange them in sentences, arrange the sentences in paragraphs in logical order, concluding with a concise summary—all the details of planning and arranging being so adjusted as to produce the effect that we have in mind. In brief, in an efficient machine the right materials are properly arranged: in an efficient composition the right words are properly placed. In literature as in practical engineering, then, efficiency is produced by heeding well-established principles; it is liable to be lost by ignoring them. The engineer ignores the principles of composition and produces much that is useless and inefficient; he heeds the principles of engineering, and produces much that is efficient and useful. In short, there is a great disproportion between his engineering and his literary efficiency.

## VAPORIZING GOLD IN THE ELECTRIC FURNACE.

Professor Moissan, in vaporizing gold in the electric furnace, finds that 100 to 150 grains can be evaporated in two or three minutes. By condensing the cold vapor on a cool surface, either filiform masses or cubical crystals can be obtained. It is found that gold, like copper and iron, dissolves a certain amount of carbon when in the liquid state, but this separates out as graphite on cooling. Gold is found to be less volatile than copper. The properties of distilled gold are the same as those of hammered gold, or the melted metal reduced to a fine powder. When an alloy of copper and gold is distilled, the vapor of copper comes over first, showing that there is no definite compound. In the case of alloys of gold and tin, the latter metal burns in contact with air. This tin oxide is found to be of a purple color, due to a deposit of fine gold on its surface.—"Mechanical World."

## STREET LIGHTING.

J. D. Ross.*

In designing a street lighting system an engineer has to consider, as in every other branch of operating, the system that will give safety, reliability, simplicity and smallest maintenance cost.

The direct-current series arc machine is scarcely to be considered in a new installment. The constant-current transformer or regulator is close to the ideal, but the alternating arc, the power factor of the line, and the powerful inductive effects on phone lines along the streets, make the alternating system inferior to the direct, as far as distribution is concerned.

The ideal system for series work in the present stage of electrical apparatus is evidently one which generates alternating constant current at the station, and after rectifying the current without the use of rotary apparatus, gives direct current for distribution to the arcs. This has been done apparently with success by means of the Cooper-Hewitt rectifier at Portland and other places, and much data is being collected as to efficiency and cost of maintenance. If this system proves a success in these respects it will probably become popular. At the present time the alternating-current system is the most simple and reliable, and has a comparatively small maintenance cost. Constant potential is changed to constant current by varying the leakage lines in a transformer or choke coil, as in the General Electric and Western Electric systems.

The General Electric system is in use in Seattle, lighting 2,950 street corners, or about 350 miles of streets. This system will be doubled as soon as material can be had and the lamps installed. When the city purchased the street system from the Seattle Electric Company the switchboard was eighteen feet long, of the usual plug type, with back primary and secondary circuits at 2,200 and 4,000 volts on the board. To double the system it was necessary to double the capacity of the board, and this extension would take up so much room that the last panel would be outside the building. To avoid this and allow for extensions for several years I designed and installed a board one-eighth of the size, having no voltage on the board higher than 110. The panels were drilled and the switches and instrument transformers were made in the shop at the sub-station.

The system consists, on the primary side, of a two-phase, four-wire, 2,200-volt main with a main switch in each phase. These are electrically controlled from a main panel which also carries the necessary ammeters, wattmeters and voltmeter plug. This main is carried through the building to the places most convenient for the placing of arc transformers, and on the side of each transformer is placed a small double-throw electric control switch operated by solenoids with open-circuit control from a pilot switch on the board. This double-throw switch connects the transformer to either phase to balance the load. The ammeter is of the horizontal edgewise type, and is operated from a 1:1 series transformer placed in the constant current arc circuit.

A small potential transformer is used on each circuit and has a secondary at 110 volts, when all the arcs of the circuit are burning. This secondary leads to the voltmeter receptacle on the board and also to a pilot lamp. As the voltage of a constant current depends on the number of arcs burning on it the voltage at the lamps, and consequently its brilliancy will rise or fall as lamps are added to or taken from the circuit, while an ordinary series pilot lamp would show no change. This lamp will show a partial or total short circuit by dimming or going completely out, while a broken line brings the lamp up far beyond normal brilliancy due to the regulation of the transformer. The controlling panel therefore contains a 6.6 ampere ammeter, a 6 pt. voltmeter receptacle, and two pilot lamps for the two circuits of the transformer and a pilot switch to control the oil primary switch. A small testing panel is placed near the transformer by which the lines may be tested at noon for short circuit, open circuit, or grounds, and which allows of the entire disconnecting or short circuiting of either of the two circuits of the transformer.

For economy of space on the switchboard each ten-inch panel is arranged to hold the equipment for two transformers so that Seattle's street lighting is controlled from a board only ninety-four inches in length, including the twenty-four-inch totalizing panel. In the outside work of arc lighting it is better to use no wire smaller than No. 6 B. & S. for mechanical strength. This, being a high-voltage wire, should be placed on the outside pin of a cross arm. Wiring down the pole, if needed to reach a lamp, should be of duplex wire of standard 3,000-volt insulation, the same as is used for the span from pole to lamp. No knobs should be used for support. The insulation should be equal or better than that of the best quality of railway insulator. If arc and telephone wires must be placed on the same pole the arc wire should be placed seven or ten feet from the phone wire and, being mechanically stronger, should be placed above.

Aside from some form of constant-current service, arc or incandescent, there has been little done in suburban street lighting. The great amount of copper required for a multiple system and the inefficiency of the incandescent lamp have kept the multiple system in the background for street work.

In the business districts, as the area to be lit is proportionately small, efficiency may be sacrificed for some form of lighting that adds beauty and dignity to a street. An even light of moderate intensity is required so that the attractiveness of sign lights and store windows will not be destroyed. The arc lamps have too great an amount of light at a point for even illumination, and the flaming arc is out of the question for any decorative design, as its strong reflections from windows hide all other lights and blinds the eye. It is a well-known fact that the eye tires and the pupil contracts under strong light, making the darkness beyond still darker to the passer-by. It is evident that the most effective lighting system is one using many small sources of light. This fact at once appeals to any one who sees a source of diffused light, such as the Moore Vacuum System.

The incandescent lamp is the nearest approach to the ideal for street work, especially if the glare of the filament is lessened by using a ground-glass or opal ball to diffuse the light. Los Angeles business became alive to the necessity of such a system of lighting, and their system is already famous in illuminating engineering circles. Denver, St. Paul and other cities are installing similar systems. Seattle's business men, on First, Second and Third Avenues, are willing to install such a system if the city will maintain it after installation. The system will be underground, using iron poles carrying incandescent lamps, the height being about fourteen or fifteen feet. Each lamp-post is supplied with switch and cut-out in the base. The underground wires follow the edge of the sidewalk on both sides of the street, and a hand-hole in the sidewalk is used to connect with the pole. I have designed a pole for this purpose, using five lamps in the form of a triangle, all being in the same plane. Each lamp will be covered with a diffusing hood to distribute the light downward and horizontally in the best proportion, the lamp and shade being covered with a ground-glass or opal ball. The lower two are supplied with eight-inch balls, the next two have ten-inch, and the top ball is twelve-inch. Seven of these poles seventy feet apart have already been erected in front of the Franklin Hotel. The light is not intense, but it is easy to read a newspaper anywhere on the street or sidewalk. About five or six amperes will be supplied to each pole, making this system a costly one for current, but, as the incandescent lamp promises to be an efficient illuminant in the future, there is a strong possibility that maintenance cost will be greatly lessened.

*Third lecture delivered by Mr. Ross to the students in Electrical Engineering, University of Washington.

## ELECTRIC HEATING AND ITS APPLICATION TO THE FUSION AND FIRING OF REFRACTORY MATERIALS.

By R. S. Hutton, D. SC.*

Quite a large number of industrial processes depend upon the production of high temperature by fuel heating. In many of these cases, in the course of general advance in practice, the limit of temperature aimed at has tended to rise considerably; but it has, unfortunately, seldom been possible to prevent a corresponding decrease in the efficiency of the utilization of the coal.

Those who make it a practice to keep constantly in mind the possibility of the introduction of improvements in such industries as these, cannot fail to have noted the remarkable progress which is being made in the application of electricity for the production of high temperatures.

Serving, at first, solely for the initiation of new industrial processes, demanding temperatures quite beyond the scope of fuel heating, electric heating is already being widely applied in cases where the temperatures required are just within the limit attainable with gas or coal firing, and the general tendency is undoubtedly towards its use for still lower ranges of temperature.

The chief advantages of the application of electricity in this connection may be said to lie, (1) in that it enables the heat to be generated just where it is required—inside, rather than outside, the chamber containing the material to be heated; (2) in the simplicity of a delicate regulation of temperature; (3) in the ease with which the furnace or kiln can be provided with a really efficient heat-insulation, capable of minimizing the thermal losses to the outside air.

### Part I.—Laboratory and Experimental Applications.

Just as the metallurgical industry has been able to make far-reaching applications of the investigations on the heat treatment of metals, so, undoubtedly, could the ceramic and allied industries benefit by a thorough and methodical experimental study of the changes in the physical properties of the various oxides and other bodies which enter into the composition of their raw materials, caused by a variation in the temperature at which they have previously been fired.

In all such cases, for laboratory purposes, the use of small furnaces or kilns, in which electric heating is adopted, offers many advantages. Without entering into detail, the following types may be briefly referred to:

(1.) Wire Wound Furnaces—In these the heating is accomplished by an electric current traversing a nickel or platinum wire wound round the tube or chamber to be heated.

For instance, a porcelain tube, which is to serve as the heating chamber, may have a spiral coil of thin nickel wire (suitable for temperatures ranging up to 1,100 degrees or 1,200 degrees coiled tightly on its outside, the tube being then jacketed with a thick layer of some heat-insulating material, preferably stratified.

Furnaces of this type in conjunction with a thermoelectric pyrometer admit of very delicate temperature adjustment; moreover, the nature of the gas atmosphere in which the heating is carried out can be varied at will.

(2.) Carbon Resistance Furnaces—Although, by substituting platinum for nickel wire in the type of furnace previously mentioned, temperatures up to about 1,350 degrees can be safely attained, the cost of platinum is for many purposes prohibitive. For the same reason, the iridium tube furnace of Nernst can scarcely be recommended except in very special cases, although temperatures of some 2,100 degrees can be reached.

Very satisfactory laboratory kilns can be constructed from carbon tubes which become heated by the resistance which they offer to the passage of an electric current. Here, again, the inside of the tube forms the heating chamber, the outside being jacketed with some material, which, in this case, must not only be a good heat insulator, but must also protect the carbon tube from oxidation. Both "carborundum fire sand" and soot have been used for this purpose with some success, and temperatures of over 2,250 degrees have been attained. At these temperatures some form of optical pyrometer, such as that of Wanner or Fery, enables the progress of the heating to be followed with considerable exactitude.

The only disadvantage of this type of furnace lies in the low electrical resistance of the carbon tubes. Currents of several hundred amperes are required, even for the smaller tubes, and with a tube of two and one-half inches internal diameter and two feet length, a current of some 1,000 amperes at ten volts is required to attain 1,900 degrees to 2,000 degrees. When alternating current is available, the installation of these tube furnaces should be possible, even in ordinary laboratories.

A rather different type of carbon-resistance furnace is that in which granular carbon, surrounding the chamber or material to be heated, serves to conduct the current. The granular carbon should be ground, sieved, and graded; the heating being much more uniform if the grains are approximately of the same size. Furnaces of this type have been widely adopted; at the Berlin Porcelain Works they have been used up to about 1,700 degrees. For really high-temperature work, however, their application is limited by the impossibility of finding a suitable refractory material of which to construct the walls of the heated chamber.

(3.) Electric Arc Furnaces—Where the very highest temperatures are required, the use of the electric arc offers many advantages. It is much easier, as a rule, to concentrate the expenditure of a large amount of power in an arc than in an ordinary resistance, and consequently the rate of heating and the limit of temperature attained is in this case frequently superior.

The arc may be open, and the heat radiated from it be thrown downwards upon the material under investigation, as in the well-known furnace used by Professor Henri Moissan, or the arc may be directly surrounded by the substance to be heated, and thus smothered. In the latter case the heat can obviously be more economically employed.

### Part II.—Industrial Processes.

In the following brief notes the chief materials to be described are carborundum, graphite, alumina, magnesia and silica; and, since many detailed accounts of some of these industries have already appeared, it is intended chiefly to deal with the recent progress which has been made.

Carborundum—The manufacture of carborundum, which is carried out at Niagara Falls, has increased steadily until now it may be considered quite an important industry.

The process consists essentially in heating a mixture of sand and coke to a high temperature. The mixture completely surrounds a central heating core of coke through which a powerful electric current is passed, the charge being kept in place by temporary walls of fire-brick. Some 5,000 horsepower is at present employed in this industry; the individual furnaces, for the most part, consume 1,000 horsepower, and each furnace is continuously run for about thirty-six hours; after which the current is switched off, and a fresh furnace started. Recently a batch of 2,000-horsepower furnaces have been installed. The output of a 1,000-horsepower furnace in thirty-six hours is about 3.15 tons (metric) of crystalline carborundum; whereas the total production of this substance in 1904 was about 3,152 tons. Although most of the crystalline carborundum is used as an abrasive, considerable quantities of "amorphous carborundum" and "siloxicon," which are both products formed at a lower temperature in a

*Abstract from an article contained in the Transactions of the English Ceramic Society.

similar type of furnace, are coming largely into use as refractory materials.

At the present time a large factory is being equipped at Niagara for the manufacture of bricks, crucibles, etc., made of "siloxicon." Much attention has been given of late to the problem of agglomerating the powdered carborundum with a view to making strong vessels of this material. Among other similar uses, the lining of kilns with bricks coated with a thin layer of carborundum may be mentioned.

Artificial Graphite—This industry, like that of carborundum, owes its development on a large scale to the inventive genius of E. G. Acheson. The process consists in the electrothermic transformation of amorphous carbon into graphite The carbon in the form of bars and rods, produced by a similar method to that employed for making carbon electrodes for arc lamps, is heated to a high temperature in a resistance furnace, very similar in type to that employed in the manufacture of carborundum, and during this heating is completely transformed into graphite. The product has been employed chiefly in the electrical industry, but recently the process has been extended, and the graphitization of lumps of anthracite coal and coke is now carried out. The resulting material is displacing natural graphite in many of its varied uses. In 1904 some 1,450 tons (metric) of artificial graphite were produced, 1,000 horsepower being continuously employed. The plant has now been duplicated owing to the increasing demand.

Fused Alumina—From quite early times investigations of the effect of high temperatures upon alumina have been carried out. The object of this work, in the first place, was the production of artificial rubies. After much painstaking work, in which other French scientists have taken part, Verneuil has succeeded in producing fairly large masses, and has recently described his most ingenious method of working.

The first extensive application of fused alumina must, however, be ascribed to the Norton Emery Wheel Company, who have for long been well known as manufacturers of abrasive articles of natural corundum, and who acquired an electric furnace process of fusing bauxite, and installed a plant at Niagara Falls. Their product is put on the market under the name of "alundum," to distinguish it from natural corundum. This process, started in 1901, has proved quite successful, the output in 1904 being 1,800 tons, practically all of which was used in the manufacture of grinding wheels and other abrasive articles. The fused product is characterized by its toughness and hardness, and is said to possess superior qualities to those of the natural material.

At Rheinfelden a similar product is being manufactured, but is called "diamantin"; the Goldschmidt "thermit" companies are also employing as an abrasive the fused alumina which occurs as a by-product of the processes which they carry out.

Of more direct interest is the application of fused alumina to the production of a new "pottery body." This development has been carried out by an important German firm of potters (Deutsche Steinzeugwaarenfabrik, of Friedrichsfeld) in conjunction with a leading chemical works. Articles made from this new material are said to possess to a remarkable degree the power of withstanding sudden heating to a high temperature. This is due to the very small contraction which occurs in articles made with suitable mixtures of the fused alumina and clay.

It would indeed be of interest to know the relative behavior of other completely "shrunk" oxides, etc., when used in a similar manner; by actual fusion in the electric furnace these materials can be obtained in a condition in which subsequent heating causes no further contraction. The strength of bodies made of such materials, when subjected to severe thermal treatment, probably depends much more upon the completeness of this "shrinking" that upon the thermal conductivity.

Magnesia—Since magnesia is the most refractory of the commonly-occurring oxides, it is surprising that it is not more widely employed for the construction of vessels capable of withstanding high temperatures. Up to the present, however, ordinary calcined magnesia has been found none too well suited for this purpose. Magnesia bricks, crucibles, etc., of nearly all makes, require very great care in handling, and it is particularly necessary in furnace work to heat them evenly and slowly, otherwise fracture occurs.

Recently the electric furnace has been used to fuse or shrink magnesia, and much may be expected by the application of such products for the manufacture of crucibles, etc.

Pure magnesia tubes and other vessels of small size are now made by the Royal Porcelain Factory at Berlin, but, on account of their high cost, are obviously of greater importance for scientific than for technical work. There is, however, nothing to hinder the cheap production of electrically shrunk magnesia on a large scale, so that further developments along these lines may confidently be expected.

Arc furnaces, very similar in general type to those employed in the manufacture of calcium carbide, have been used technically for the production of fused alumina and magnesia, and, where it is desirable to produce a really fused and liquid product, there are somewhat great difficulties in the way of using a resistance furnace with material packed around a central core. On the other hand, much can be done with resistance furnaces, and large masses of magnesia can be heated to near the melting point, and caused to recrystalize, with a very simple type of furnace, and with considerably lower power expenditure than is incurred with the arc type of furnace.

Silica Glass—The fusion of quartz has, within the last few years, shown signs of developing into a flourishing little industry.

Recently the electric furnace has been called into service with most satisfactory results. Relatively large tubes have been obtained from quartz crystal or Calais sand, both by indirect heating with the electric arc and also by passing the electric current through a carbon core surrounded by sand. Recently the electrical process has been developed, and a method discovered for blowing and shaping vessels from the semi-fluid material, produced around an electrically-heated core. With these and other improvements, the Thermal Syndicate, of Wallsend-on-Tyne, is producing large pipes, bricks, dishes, insulators, pyrometer tubes, and a variety of other ceramic articles.

The fused silica has most valuable properties; not only can it withstand extreme and sudden changes of temperature, but its highly refractory nature and extreme hardness should also assure it numerous applications in the chemical and other industries.

On account of the inclusion of small air bubbles in the plastic mass, and the impossibility of bringing silica into a really fluid condition, up to the present time a perfectly transparent material has not been obtained in large masses. The translucent nature of the product will, however, enable it to be used for many purposes in addition to those mentioned above.

---

Oakland, Cal.—The Southern Pacific Co. has been quietly making arrangements for the extension of its Webster Street line out Franklin Street from Fourteenth to Twentieth Street, at which point it will deflect westward from San Pablo Avenue and connect with its line in West Oakland, thus making a loop through the center of the city and connecting both moles of the company. The construction of the new line will make the Southern Pacific a formidable rival for a large volume of passenger business that the Key Route has been zealously striving to secure. The company officials say that the work on the new electric line, or rather the changing of the present steam lines to electric power, will be pushed forward as rapidly as possible, and that the change in the system, together with the rolling stock under the contracts, will cost nearly $2,000,000.

The JOURNAL of ELECTRICITY POWER AND GAS

Published Weekly by

THE TECHNICAL PUBLISHING COMPANY

SUCCESSORS TO

The Journal of Electricity Publishing Company

304 Atlas Building, San Francisco.

Yearly subscription, $2.50. Single copies, 10 cts. Back numbers prior to the current month, 25 cts. Foreign subscription, $4.00. Subscriptions cannot be begun with back numbers. Manuscripts submitted must be accompanied by postage to insure return.

Address all communications and make all remittances payable to The Technical Publishing Company.

EASTERN AGENCIES

NEW YORK .....
CHICAGO . . .....
ST. LOUIS .....

WESTERN AGENCIES

LOS ANGELES .....
PORTLAND . . .....
SEATTLE . . .....

Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," with which is incorporated "The Engineers', Architects' and Builders' News."
Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as "The Electrical Journal," July, 1895.
Entry changed to "The Journal of Electricity," September, 1895.

VOL. XVIII MARCH 30, 1907 No. 13

# EDITORIAL.

**The Determination of the Average and Maximum Power Demand.**

Probably the most important point involved in the distribution and disposition of electrical energy is the determination of the cost per unit of consumption, or per kilowatt-hour as affected by the character of the demand during each twenty-four hour period. For any given quantity of energy used during each month it is possible that the cost of producing and delivering to the customer and therefore the selling price may be increased or diminished through a very wide range, depending solely on the average and maximum use during the month. The cost of power naturally varies with the cost of fuel or the cost of generation and transmission to the point of consumption, but the so-called "load factor" is undoubtedly to be given the most careful investigation after the other factors have all been accurately determined.

Innumerable efforts have been suggested and some fairly satisfactory schemes put into operation, to commercially establish the relation of the maximum demand and the average use. The very compact and reliable integrating wattmeter is an exceedingly satisfactory instrument to measure the total kilowatt-hour use during any period and from the total energy the average demand may be found by dividing the kilowatt-hours by the total number of hours during which power has been used. The difficulty, however, is to ascertain within a reasonable range of error, not only what the maximum demand for power is, but also to get a record of the length of time during which the maximum load continues.

The ordinary recording electrical instruments with twenty-four-hour charts cannot be depended upon for anything more than approximate readings, or rather, indications. Not only must the charts be renewed daily but large and sudden variations of load tend to seriously impair the accuracy of the instrument. Continuous recording instruments have been introduced more especially for indicating the load in kilowatts, but the amount of care and attention they require, coupled with the serious effects which may result from sudden changes in load, excludes them from use in many instances. All types of recording instruments are open to the objection that the momentary swing of the needle, or recording device, exaggerates the fluctuation, and the record therefore indicates a larger load than actually occurs when the load is suddenly increased, and, similarly, a smaller load is recorded than the actual minimum, in case of a sudden reduction in the demand.

Maximum demand ampere indicators that operate as a result of the heating effect of the current are free from this objection; in fact, in most types, very short or sudden increases of load do not affect the instrument at all. The construction of the maximum demand ampere indicators is very simple, and they can be depended upon, in most cases, to give good commercial results. They are, however, open to the objection that they do not indicate the maximum power, but only the maximum current, which, with alternating current, is not proportional to the power, except at unity power factor and constant voltage. Even when used with direct currents or alternating currents at high power factors it is important to also get records of the voltage at times of greatest load. The fact that the maximum ampere demand meters are made slow acting or sluggish, to a great extent offsets the objection that they are ampere indicators, rather than power-measuring devices, particularly when used on alternating current circuits, where the starting of induction motors causes temporary and very short current demands at low power factor.

## A CORRECTION.

In our issue of December 29th we published in the department of the "Journal" devoted to Industrials, a short article, headed "Some Recent Western Sales of the Allis-Chalmers Company," and in this article conveyed the impression, unintentionally, that the Edison Electric Company, of Los Angeles, had installed at Caliente, on the Kern River, five 3,200-kilowatt Allis-Chalmers alternating-current generators.

Since that time both the General Electric Company and the Allis-Chalmers Company have written us that this statement was a mistake, and requested a correction. As a matter of fact, the Allis-Chalmers Company did supply five generators as noted above for a plant at Caliente, but this plant is not controlled by the Edison Electric Company.

Whenever the "Journal" inadvertently publishes a statement which is not authentic, we wish, in justice to all concerned, to make all possible reparation, by publishing the facts only.

## BOOK REVIEW.

The Pacific Coast Gas Association has just published in very attractive form the papers entitled "The Compression and Transmission of Illuminating Gas" and "Some Economics in High-pressure Gas Transmission," by Edward A. Rix. These were read at the meetings of the association of 1905 and 1906. Illustrated with charts and tables, it forms a valuable authority on the transmission of illuminating gas.

## TRADE CATALOGUES.

**General Electric Co. Bulletins—**

No. 4485—A portable gasoline engine and generator outfit. The engine is of a four-cycle, four-cylinder, six-inch diameter by six-inch stroke, water-cooled type. The generator direct connected thereto is of the revolving-field type with a range of alternating current for 32, 55 and 110 volts. The complete set is mounted on a common base, which is in turn bolted to skids so that it may be carried on a truck, or as a sled.

No. 4487—A small-plant, continuous-current switchboard. This is a standard type, and is suitable for small continuous-current isolated plants.

No. 4488—Thompson Recording Wattmeter. This supersedes Bulletin No. 4415.

No. 4489—Crane wiring supplies. This shows equipment for installing crane motors.

No. 4490—Is devoted to the description of a portable air compressor set.

No. 4491—Superseding Bulletin No. 4369. Describes the R-84-C Controller, adapted to power and mining service.

No. 4492—Small-plant, alternating-current switchboards for three-phase, small lighting systems.

## RATING OF RAILWAY MOTORS.

The question of determining whether a better form of rating of railway motors can be prepared than that now used is now occupying the attention of the standardization committee of the A. I. E. E., and in the meetings of the committee there has been a spirited interchange of opinions on this subject by representative railway motor men.

In connection with this discussion the "Street Railway Journal" comments as follows:

"The present method of designating railway motors, the so-called 'commercial rating,' consists in fixing the horsepower output of the motor which will raise the temperature of the hottest part seventy-five degrees C. after a stand test of one hour with covers removed. This rating of railway motors has been handed down from the early days of elecrtic railroading, and its strongest advocates have urged its continuance only on the ground of its serving the purpose of an excellent commercial test of both the electrical and mechanical qualities of the motor. They admit that the one-hour rating is not a definite indication of the fitness of a motor for a given service, nor is it a true comparison between motors of different capacities, but they claim that it does have the advantage of expressing in a single simple term an approximate comparison of the electrical and mechanical qualities of motors of different capacities.

Owing to the complicated nature of the calculations involving the selection of a railway motor and the different methods in use by the different manufacturing companies and outside engineers in arriving at its selection, the time may not yet be ripe to settle upon any one method of railway motor determination. To complicate the matter still further, any expression indicating the true service capacity of a motor can probably not be reduced to a single term, but must be put in the form of several terms, or, better still, in curve form. As a method of "rating" railway motors a curve would seem impossible, although it would be extremely useful as indicating the service capacity of the motor. It seems a very wise suggestion, therefore, to continue the one-hour rating of railway motors and not to demand at the present time any universal adoption of the several service determinations offered, owing to the very apparent lack of agreement among authorities. At the same time, and to compensate consulting engineers for the non-adoption of a more satisfactory service rating of railway motors it appears proper to include under the head of "desirable information to be furnished," such data in regard to thermal capacity of the motors, core losses, copper losses, and other internal losses, together with continuous current carrying capacity at different voltages with seventy-five degrees rise, and such other data as would enable a consulting engineer to make as many service calculations as he may desire.

At present the selection of railway motors rests largely in the hands of the manufacturers, a decision which has been rather forced upon them, owing partly to their desire to insure satisfactory service operation of their apparatus and partly owing to the unpreparedness of the outside engineering profession to act in this matter. The determination of the service capacity of a railway motor is a matter involving elaborate tests and considerable expense, and it is proper that such tests should be made by the manufacturer. There seems to be no reason, however, why results of these tests should not be more widely distributed so as to be available to the consulting engineer who may have the experience and inclination to apply the experimental thermal characteristics of the various motors to a concrete problem. The consulting engineer, if thoroughly informed of the requirements of a projected road, and having the thermal characteristics of the various motors as determined by the manufacturers, can then make fully as intelligent a selection as the latter, provided he is willing to give the time necessary for perhaps rather long and tedious calculations. It makes little difference to the consulting engineer whether this additional information about railway motors is presented in the form of a "rating" or not. The main point is to ventilate more widely the conditions governing the operation of railway motors and to be in possession of sufficient test data to simplify the solution of this very perplexing question.

## THE INSTITUTION.

The announcement which we make in another column that Lord Kelvin has accepted nomination for the office of President of the Institution of Electrical Engineers for the session of 1907-8, will be read with much satisfaction by all sections of the electrical engineering community. That such signal honor should be conferred upon our Institution by the doyen of electrical science in this country, who has already occupied the presidential chair on two occasions, is a matter for congratulation, and it shows how closely Lord Kelvin keeps in touch with electrical engineering progress on the practical as well as on the theoretical side. It was in 1874 that Lord Kelvin was elected for the first time, and in 1889 he was again elected. During the current session he is acting as president of the Glasgow Local Section, and has evinced much interest in the affairs of the local branch—notably on the occasion of the visit of the representatives of foreign electrical societies to Glasgow last summer. We have no doubt that Lord Kelvin's acceptance of the presidency of the parent Institution for the third time will stimulate the interest of its members and add to its usefulness.

Spokane, Wash.—Extensive changes in the system of the P. S. Tel. & Tel. Co. are under way. The principal change is the installing the central energy system.

# INDUSTRIAL

## COMPARISON OF VARIABLE SPEED SYSTEMS.*

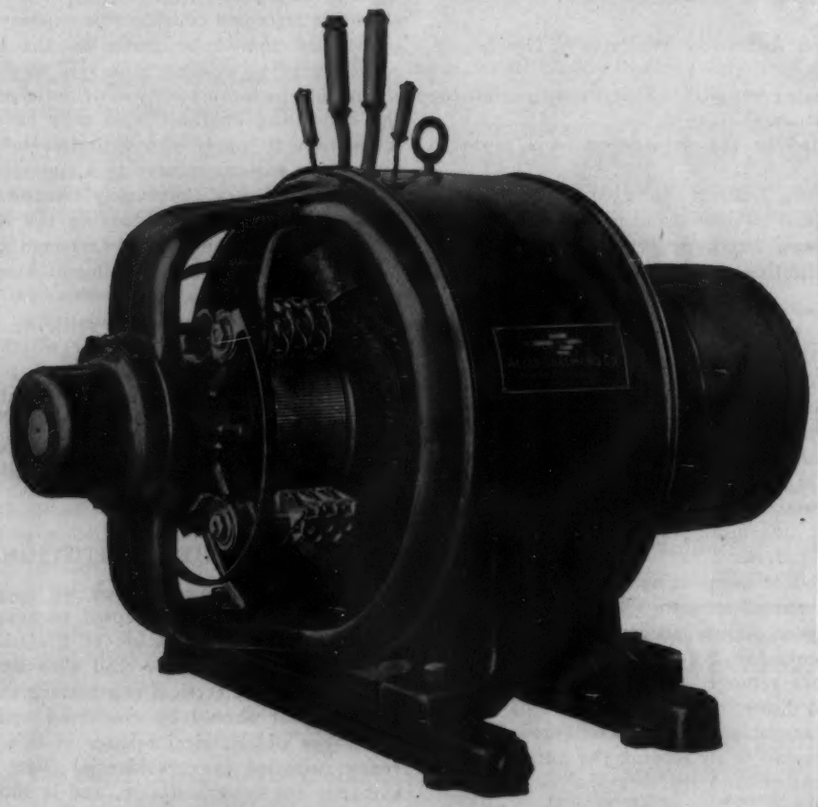
In making a comparison of the merits of the systems most commonly used there are two points to carefully consider. The size and weight of a motor is dependent to a great extent on the minimum speed at which the motor is required to develop its full rated power, and the slower the minimum speed the greater will be the size and weight for a given horsepower output. As a gear or chain drive is used on motors operating machine tools, the maximum speed of the motor is dependent on the peripheral speed of the motor pinion, or upon the maximum ratio of speed reduction between the driven shaft and the motor shaft. This limits the maximum speed of motor to 1,000 to 1,600 revolutions per minute, depending upon the output of the motor.

In order to show clearly the performance of a motor on power developed by a motor which has a rating of 10-horsepower, 240 volts, 600 revolutions per minute, when operated at constant speed and continuous service. This motor will stand a current overload of 40 per cent. for intermittent service, such as machine tool duty, without undue heating or sparking when operated at full field strength, and will therefore be rated at 14-horsepower, 240 volts, 600 revolutions per minute intermittent duty. The speed can be increased from 600 to 1,200 revolutions per minute and the motor rated at 10-horsepower at the high speed without sparking at the brushes. For the intermediate speeds between 600 and 1,200 revolutions per minute the rating of the motor will gradually decrease from 14-horsepower to 10-horsepower as the motor speed is increased. For horsepower ratings at lower voltages the current overload with full field strength will be the various systems, a comparison will be made with the the same as for 240 volts, and this will decrease as the speed is increased by weakening the fields.

Assume that the motor will be used on a 30-inch engine lathe and the gearing changed to suit the particular requirements of the system on which the motor is to be operated. A standard armature will be used on the three-wire and four-wire systems and a special armature on the two-wire. The swing-over carriage will be 20 inches, swing-over shears, 30 inches, and the power and speed requirements of the lathe as follows:

The minimum speed of the lathe should give a cutting speed of 30 feet per minute on the maximum diameter. This will be 4 revolutions per minute. The maximum speed of lathe should give a polishing speed of 200 feet per minute on 2½-inch diameter. This will be 320 revolutions per minute. The total speed range will, therefore, be 80:1, or from 320 revolutions per minute to 4 revolutions per minute.

As this lathe will swing but 20 inches over the carriage, the maximum power will be required on diameters of work less than 20 inches, say, from 19 inches to 3.8 inches, between which sizes the lathe will be required to turn steel, the size of cut being ¼ inch by 1/16 inch at 80 feet per minute. This will require 8 horsepower on spindle speeds between 16 revolutions per minute and 80 revolutions per minute. On diameters below 3.8 inches the size of cut will gradually decrease, and this will cause a corresponding de-



ALLIS-CHALMERS TYPE "K" MOTOR—OPEN STYLE.

*Courtesy of the Allis-Chalmers Company.

crease in the power required by the lathe. At the minimum speed of 4 revolutions per minute a cut of ¼ by 1/16 at 30 feet per minute on cast iron will require 2 horsepower.

From 4 revolutions per minute to 16 revolutions per minute the power required by a lathe will increase with speed from 2 horsepower to 8 horsepower. From 16 revolutions per minute to 80 revolutions per minute the power will be constant at 8 horsepower. From 80 revolutions per minute to 320 revolutions per minute the power will gradually decrease to 5 horsepower.

**Two-wire Single-voltage System.**

Speed of Motor, 440 to 1,200 Revolutions Per Minute.—Four Runs of Gearings.

| Motor | | Third Back Gear | | Second Back Gear | | First Back Gear | | Direct | |
|---|---|---|---|---|---|---|---|---|---|
| Speed | H. P. | Speed | H. P. | Speed | H. P. | Speed | H. P. | Speed | H. P. |
| 440 | 10.2 | 4 | 2 | 12.4 | 6 | 38.4 | 8 | 116 | 7.2 |
| 520 | 10 | 4.7 | 2.3 | 14.6 | 7.3 | 45 | 8 | 136 | 6.9 |
| 600 | 9.8 | 5.4 | 2.7 | 17 | 8 | 52 | 8 | 153 | 6.6 |
| 690 | 9.3 | 6.4 | 3.2 | 20 | 8 | 61 | 8 | 185 | 6.3 |
| 800 | 8.8 | 7.3 | 3.7 | 22.6 | 8 | 70 | 8 | 214 | 6 |
| 920 | 8.4 | 8.4 | 4.2 | 26 | 8 | 80 | 8 | 245 | 5.7 |
| 1050 | 8 | 9.5 | 4.8 | 29.5 | 8 | 91 | 7.8 | 280 | 5.4 |
| 1250 | 7.5 | 11 | 5.5 | 34 | 8 | 105 | 7.5 | 320 | 5 |

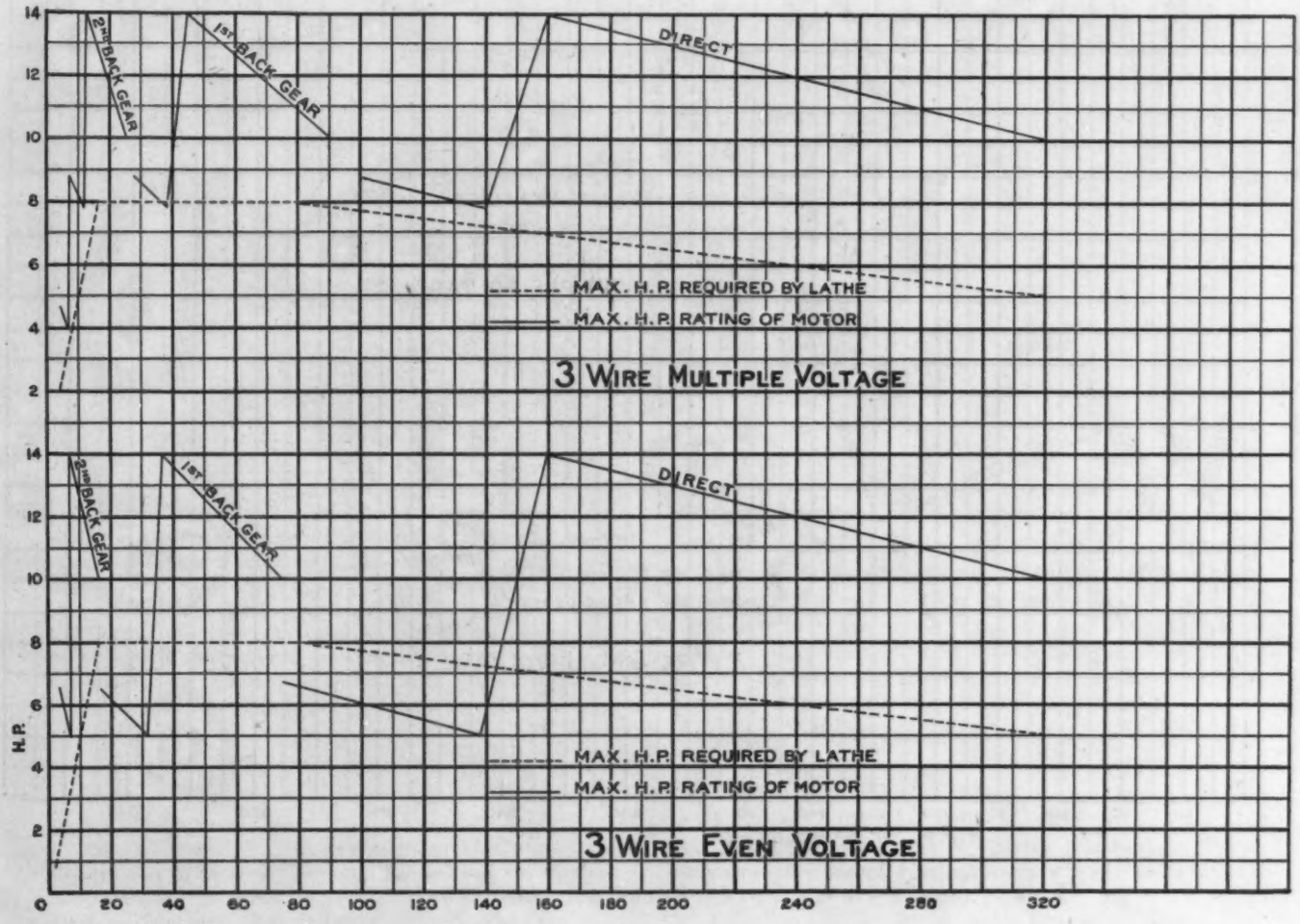

H.P.
2nd BACK GEAR
1st BACK GEAR
DIRECT
MAX. H.P. REQUIRED BY LATHE
MAX. H.P. RATING OF MOTOR
3 WIRE MULTIPLE VOLTAGE
2nd BACK GEAR
1st BACK GEAR
DIRECT
MAX. H.P. REQUIRED BY LATHE
MAX. H.P. RATING OF MOTOR
3 WIRE EVEN VOLTAGE
0 20 40 60 80 100 120 140 160 180 200 240 280 320

FIGURE 1.

There is only one point in the speed range where the power of the motor is less than that required by the lathe, namely 34 revolutions per minute, where the required power of lathe is 8 horsepower and motor is 7½ horsepower. This motor requires, however, four runs of gearing, which is more complicated and expensive than is required by the other systems which have only three runs of gearing.

**Three-wire Even Voltage.**

Speed of Motor, 280 to 1,200 Revolutions per Minute. Three Runs of Gearing.

| Motor | | Second Back Gear | | First Back Gear | | Direct | |
|---|---|---|---|---|---|---|---|
| Speed | H. P. | Speed | H. P. | Speed | H. P. | Speed | H. P. |
| 280 | 6.5 | 4 | 2 | 17.2 | 8 | 75 | 8 |
| 325 | 6 | 4.65 | 2.3 | 20 | 8 | 87 | 7.8 |
| 375 | 5.6 | 5.35 | 2.7 | 23 | 8 | 100 | 7.5 |
| 450 | 5.3 | 6.45 | 3.2 | 27.9 | 8 | 119 | 7.2 |
| 520 | 5 | 7.35 | 3.6 | 31.7 | 8 | 138 | 6.9 |
| 600 | 14 | 8.55 | 4.3 | 37 | 8 | 160 | 6.6 |
| 690 | 13 | 9.85 | 4.9 | 42.5 | 8 | 185 | 6.3 |
| 800 | 12 | 11.4 | 5.7 | 49 | 8 | 214 | 6 |
| 920 | 11 | 13.1 | 6.6 | 56.3 | 8 | 245 | 5.7 |
| 1050 | 10.5 | 15 | 7.3 | 64 | 8 | 280 | 5.4 |
| 1200 | 10 | 17.1 | 8 | 73.5 | 8 | 320 | 5. |

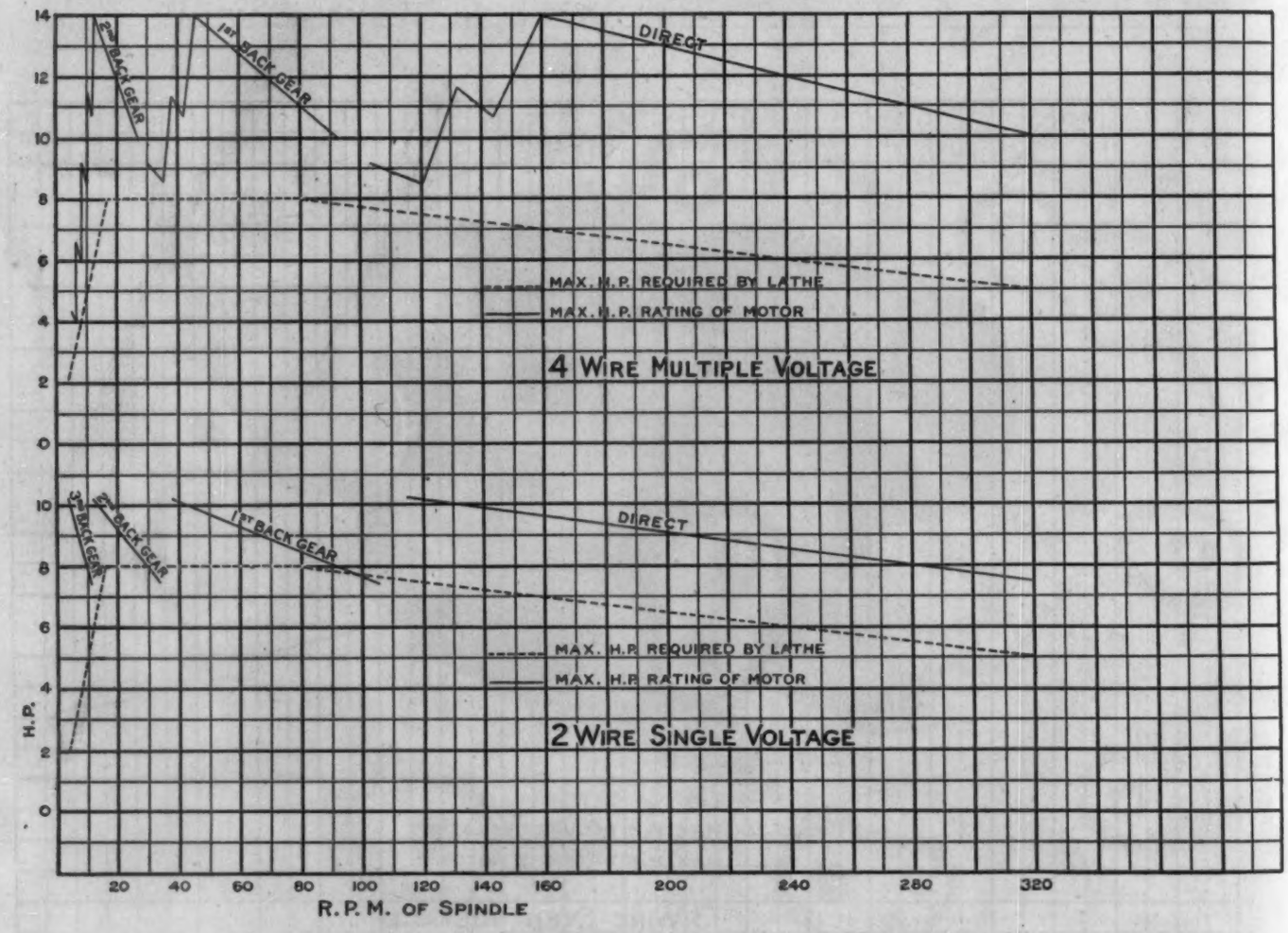



FIGURE 2.

With this system the motor will develop from 6.5 horsepower to 5 horsepower between the ranges in spindle speed 17.2 and 31.7 and from 75 to 138 revolutions per minute. The power required by the lathe for these spindle speeds is 8 horsepower. In order to obtain the required power by the three-wire even voltage the size of motor must be increased 60 per cent. There would, furthermore, be no advantage in using a lesser speed range and a greater number of runs of gearing, unless the speed range were decreased 2:1, in which case the motor would be operated on a two-wire system instead of on a three-wire even voltage.

**Three-wire Unequal Voltage.**

Total Range of lowest Run of Gearing, 194 to 1,200 Revolutions per Minute. Partial Range on Other Runs, 375 to 1,200 Revolutions per Minute. Three Runs of Gearing.

| Motor | | Second Back Gear | | First Back Gear | | Direct | |
|---|---|---|---|---|---|---|---|
| Speed | H. P. | Speed | H. P. | Speed | H. P. | Speed | H. P. |
| 194 | 4.6 | 4 | 2 | | | | |
| 225 | 4.4 | 4.64 | 2.3 | | | | |
| 280 | 4.2 | 5.77 | 2.9 | | | | |
| 325 | 4 | 6.7 | 3.4 | | | | |
| 375 | 8.75 | 7.22 | 3.6 | 28 | 8 | 100 | 7.5 |
| 450 | 8.3 | 9.28 | 4.6 | 34 | 8 | 119 | 7.2 |
| 520 | 7.8 | 10.7 | 5.4 | 39 | 8 | 139 | 6.9 |
| 600 | 14 | 12.4 | 6.2 | 45 | 8 | 160 | 6.6 |
| 690 | 13 | 14.2 | 7.1 | 51.5 | 8 | 185 | 6.3 |
| 800 | 12 | 16.5 | 8 | 60 | 8 | 214 | 6 |
| 920 | 11 | 19 | 8 | 69 | 8 | 245 | 5.7 |
| 1050 | 10.5 | 21.7 | 8 | 78.5 | 8 | 280 | 5.4 |
| 1200 | 10 | 24.7 | 8 | 90 | 7.8 | 320 | 5 |

There is only one point in speed range where the capacity of the motor is less than that required by lathe, namely, 39 revolutions per minute. At this point the capacity of the motor is 7.8 horsepower and the power required by the lathe is 8 horsepower.

**Four-wire Multiple Voltage.**

Total Range on Lowest Run of Gearing, 180 to 1,200 Revolutions per Minute. Partial Range on Other Runs, 390 to 1,200 Revolutions per Minute, Three Runs of Gearing.

| Motor | | Second Back Gear | | First Back Gear | | Direct | |
|---|---|---|---|---|---|---|---|
| Speed | H. P. | Speed | H. P. | Speed | H. P. | Speed | H. P. |
| 180 | 4.25 | 4 | 2 | | | | |
| 225 | 4 | 5 | 2.5 | | | | |
| 280 | 6.5 | 6.22 | 3.1 | | | | |
| 325 | 6 | 7.22 | 3.6 | | | | |
| 390 | 9.1 | 8.68 | 4.3 | 30 | 8 | 104 | 7.5 |
| 450 | 8.5 | 10 | 5 | 34.6 | 8 | 120 | 7.2 |
| 495 | 11.5 | 11 | 5.5 | 38 | 8 | 132 | 7 |
| 540 | 10.7 | 12 | 6 | 41.5 | 8 | 144 | 6.8 |
| 600 | 14 | 13.3 | 6.7 | 46.2 | 8 | 160 | 6.6 |
| 690 | 13 | 15.3 | 7.7 | 53 | 8 | 185 | 6.3 |
| 800 | 12 | 17.8 | 8 | 61.5 | 8 | 214 | 6 |
| 920 | 11 | 20.5 | 8 | 70.8 | 8 | 245 | 5.7 |
| 1050 | 10.5 | 23.3 | 8 | 81 | 8 | 280 | 5.4 |
| 1200 | 10 | 26.7 | 8 | 92.5 | 7.8 | 320 | 5 |

In this system the motor has sufficient capacity at all points in the speed range. The increase in capacity, is, however, not sufficient to warrant the use of this system instead of the three-wire unequal voltage, on account of additional expense.

One of the most important features of our system is that it lends itself admirably to existing installations. Any motors can be run on this system without any change whatever, it being only necessary to supply the system with two or more different voltages and add the required controllers. In manufacturing plants where tools are installed that are supplied with mechanical speed-changing devices, constant-speed shunt motors may be used and run on the outside wires of the multiple voltage system. The motors used for this kind of service should, however, meet with certain requirements, and for this purpose the Allis-Chalmers direct-current motors are especially adapted.

---

Mr. William H. P. Hill, general manager of the Monterey County Gas & Electric Company, has secured the services of Mr. Frederick S. Mills as general superintendent, and Mr. Frederic Southerland as assistant superintendent.

Mr. Mills was, until recently, connected with the General Electric Company, as a traveling agent for machinery.

Mr. Southerland, a former Cornell man, has been on the Coast only a few months, coming from the New York Edison Company, in New York City.

The Monterey and Pacific Grove Railway, controlled by the Monterey County Gas & Electric Company, will soon commence the work of rebuilding the road, and a greatly improved service is confidently expected.

The M. C. G. & E. Co. has just placed an order with the General Electric Company for two 500-kilowatt Curtis turbo-generators, and the Charles C. Moore Company has been given the contract for boilers. This equipment, when completed, will make the Monterey plant one of the most up-to-date installations on the Coast, and arrangements have been made for more units as required.

# NEWS NOTES

## TRANSPORTATION.

Monterey, Mexico.—Chinese residents of Torreon, headed by Foon Chuch and Dr. J. W. Limm, have secured a concession to build an electric railroad beginning at New Torreon, where they have large holdings. They will spend $200,000.

San Diego, Cal.—The city is advertising for bids for a franchise for the construction of a street railway from Winler and India Streets to the water front at Ocean Beach. The bids will be opened on April 1st and the franchise will then be awarded.

Porterville, Cal.—At a meeting of the Board of Trustees last week an application for a permit to lay tracks and string wire in the streets of Porterville was presented. The permission was sought by the Sierra Pacific Railroad Company. The promoters expect to build in a short time.

San Diego, Cal.—Notification that the work on the Adams Street car line, which will be built eastward from the Pavilion through Normal Heights by the San Diego Electric Railway, will be commenced immediately was received last week by D. C. Collier, president of the Ralston Realty Company.

Long Beach, Cal.—George W. Hughes, president of the Signal Hill Improvement Club, is at the head of a syndicate which intends to furnish rapid transit from Long Beach to the summit of the hill. Some time ago a petition was filed with the City Trustees asking for a franchise for tracks along certain streets of the city and running northeast to the top of Signal Hill.

Los Angeles, Cal.—Three franchises for the extensions of proposed electric lines have been sold by the Board of Supervisors to the Los Angeles Pacific Co. for $100 a piece. The roads run to Irwindale and Hollywood. An application from the Pacific Electric Co. for the extension of its Temple Street line beyond the city limits was referred to the district attorney.

San Diego, Cal.—At the special meeting held February 26th the street committee of the City council recommended an ordinance granting a franchise to H. W. Keller and W. C. Kerckhoff, of Los Angeles, for an electric railway from H Street, in this city, north to Del Mar. There must be $50,000 worth of construction work done each six months from the time construction begins.

Nevada City, Cal.—John Martin, promoter of the California Midland Railroad, has been here, accompanied by his chief engineer, Chas. Trow. They are looking over the local situation and completing deals for rights-of-way, several of which have already been paid for. They plan to connect with the local interurban line to Grass Valley, and have certain pieces of property under bond for a terminal site.

Oakland, Cal.—F. M. Greenwood, who obtained a franchise a year ago from the Board of Trustees of the City of Alameda to build and operate an electric railway through that city in connection with a ferry service to San Francisco, has organized a company for that purpose, under the name of the San Francisco, Alameda and Eastern Railway Co. The company has a capital of $2,000,000. The directors are F. M. Greenwood, A. D. Schwindler, A. H. McHuron, W. H. Spald-

Los Angeles, Cal.—The Ontario and San Antonio Heights Railway Company, owned and controlled by the Pacific Light and Power Company of this place, has commenced work on its new extension across San Antonio Heights to a park of 200 acres just west of Mountain Avenue. Manager Burt has planned many attractions at the new park, and a tourist hotel is being planned in the vicinity.

Los Angeles, Cal.—A contract has been awarded by the Los Angeles Interurban Railway Company to R. Shere & Company to complete all grading and other work for the roadbed of the double-track railway known as the Monrovia-Glendale line. The consideration is to be 18 cents per cubic yard for earth excavation, 40 cents per cubic yard for loose and hard-pan excavation, 75 cents for solid rock and 18 cents for embankment.

Alameda, Cal.—Oliver Ellsworth, representing F. M. Greenwood, who was granted a franchise some time ago to construct an electric road on Clement Avenue to connect with the proposed ferry system to San Francisco, notified the City Clerk that Greenwood was prepared to place in escrow the required $50,000 guarantee that he will carry out the terms of the franchise, but at the appointed time the money was not forthcoming.

Los Angeles, Cal.—An ordinance has been adopted giving W. C. Weaver the right to construct and operate a double-track railroad upon certain public streets in Los Angeles. The proposed line is to run from the corner of Piedmont and Pasadena Avenues along Pasadena to New York Street and along this to the western boundary of the city. A branch is to commence at New York and Latrobe and run along the latter to Eagle Rock Avenue and along this to the city limits.

San Jose, Cal.—L. E. Hanchett of the San Jose-Santa Clara Railroad Company has been granted franchises for which he petitioned the Mayor and Council. The entire system will be made broad gauge, and the new cars to run on it will be bought at a cost of $14,000 each. Altogether the work is expected to cost over $1,000,000. New lines are to be built on Third, Fifth, Eighth and Jackson Streets, from Antonio Street to Second. The management of the entire system will be in the hands of C. C. Benson.

Long Beach, Cal.—H. C. Oakley of Los Angeles, the agent who has secured the right of way for the proposed four-track railroad between Los Angeles and Long Beach, by way of Gardena, has gone further and secured valuable sites on the flats west and northwest of here. The property could be useful as a terminal site for an overland railway, and W. B. Redburn has said that there is no doubt that the property was secured for a transcontinental line seeking access to Long Beach harbor.

Stockton, Cal.—The application of the Central California Traction Company for a franchise to carry freight over its lines to this city, as presented to the Council recently, disclosed the fact that the company is projecting 175 miles of road in this county, to connect with other roads in other counties. The motive power will be electricity. The application set forth the fact that there will be a line from Sacramento to Lodi, thence to Stockton, and one to Modesto, a distance of 90 miles. A branch line will be run from Lodi to Walnut Grove.

Sacramento, Cal.—It is announced that the Sacramento Electric, Gas and Railway Company has placed an order for fourteen additional street cars, modern in every respect, to be used on the lines of this city. General Manager Fitzpatrick is authority for the statement that the company proposes to keep abreast with the growth of the city and that service will be made seven and a half minutes on several

lines where it is now ten minutes. The change will be made as soon as the new cars are delivered.

San Francisco, Cal.—A street car strike is expected by Mayor Schmitz, as is witnessed by the following passage from a letter sent to Police Commissioner Cresswell: "I received information a few days ago to the effect that on May 1st another car strike would take place. Of course, I intend to avert it if possible. If a strike does take place—and from all accounts it seems almost unavoidable—your position naturally would be inconsistent as a member of the Police Commission. I therefore think it advisable to accept your resignation, which was forwarded to me some time ago."

Pasadena, Cal.—The most important announcement concerning the changing of the local street care system which has been made since the agitation for less congested traffic commenced, came this week from Jas. B. Rowray, superintendent of the northern division of the Pacific Electric. He goes on record as favoring the loop system. His utterances are guarded, but they imply that he believes that the loop plan, as outlined by several business men, will fill the bill, and when Huntington returns in the Spring he will dispose of the question.

San Francisco, Cal.—The United Railroads will begin service on the Sacramento Street line from Fillmore to the ferry before long. While a large gang of men is working on the western end of the line another force will soon be put to work completing the loop at the ferry, which will give safer service to patrons than the old curve at Sacramento and East Streets. After leaving Fillmore Street the cars will go down Sacramento to Larkin and thence over Larkin to Clay, and down Clay to the water front. The tracks will run along East Street until they come to the gore at Sacramento and Market, where they will join the western curve of the Market Street loop for a few feet. They will then round the gore and branch off up Sacramento to Fillmore. In this way the Sacramento Street cars and those rounding the Market Street loop will be going in the same direction at a safe distance from the Market Street curb.

## INCORPORATIONS.

San Francisco, Cal.—A certificate of diminution of stock has been filed by the Central Light and Power Co.

Seattle, Wash.—The Globe Electric Co., capital $25,000, has been incorporated by J. A. Reardon, A. C. Weaver, Frank Becker and P. J. Knight.

Oakland, Cal.—With a capital stock of $200,000 the Borein Water Co. has been incorporated. L. H. Bell, C. A. Borein and C. C. Hamilton are backing the project.

Antioch, Cal.—An assessment has been declared by the Antioch Oil Co. of one and one-half per cent per share, delinquent March 16th, sale day March 16th.

St. Anthony, Ida.—The Peaceful Valley Imp. Co., Ltd., has been granted a fifty-year franchise for the erection of a power line in Fremont County.

Santa Barbara, Cal.—The Santa Maria Oil and Transportation Co. has been incorporated here with a capital stock of $1,000,000, of which $3,500 has been subscribed.

Napa, Cal.—H. M. Pitman, T. B. Pitman, and G. S. Cutler have incorporated the Napa Valley Power Co., with a capital stock of $200,000, of which $30 has been subscribed.

Eureka Cal.—The Humboldt Gas and Electric Co. has been incorporated with a capital stock of $1,500,000, shares $3 each, $15 subscribed.

Visalia, Cal.—The Exeter City Water Co., with a capital stock of $25,000, shares $25 each, has been incorporated with $125 subscribed.

Redwood City, Cal.—The San Mateo Water Co. has been incorporated with a capital stock of $500,000. Jos. Levy, W. F. Turnbull, H. N. Royden, J. A. Foster and C. N. Kirkbride have each taken one $100 share.

Los Angeles, Cal.—At the last meeting of the City Council, held February 25th, there was a discussion of the proposed water bond issue of $23,000,000. No definite action was taken.

San Francisco, Cal.—The Green Creek Electric Power and Water Co. has been incorporated here by G. E. Weaver, J. G. Weir and E. T. Zook, with a capital stock of $5,000. Shares are $1 each.

Los Angeles, Cal.—The Lockwood Oil Co. has just been incorporated with a capital stock of $500,000, $25.00 being subscribed by T. Spellacy, P. E. Spellacy, C. S. Young, W. M. Wallace and J. D. Thompson.

Los Angeles, Cal.—The Cresceus Oil Co. has been incorporated here with $320,000 capital stock. There has been $25.00 subscribed by J. D. Lundregan, J. L. Scott, John Conley, T. and P. E. Spellacy.

Fresno, Cal.—The Elaine Oil Co. has been incorporated with a capital stock of $300,000, by Z. L. Phelps, W. C. Reilly, E. W. Robinson, John Mills, Arthur E. Webb, E. A. Webb and S. J. Riley.

Santa Barbara, Cal.—The Yucca Oil Co. has been incorporated to develop petroleum. The capital stock is $500,000 and the incorporators are J. F. Forbes, H. H. Younken, Stone Hastain and others, all of Orcutt.

Los Gatos, Cal.—With a capital stock of $200,000 the Los Gatos Ice, Gas & Electric Co. has recently been incorporated here. Shares are $16 each. Jay Deming, G. W. and C. E. Hume, J. D. and Bessie Farwell have taken one share each. Place of business, San Francisco.

Santa Maria, Cal.—The Prince Canyon Oil Co. has incorporated with Geo. Doane, Jr., T. B. Adams, L. C. Mau, and others, directors. They will get the best machinery and begin drilling on the Price Ranch, near the Tiber Company's well. The property is located a few miles from Oilport.

Fresno, Cal.—The Skookum Oil Company has been incorporated with a capital stock of $300,000, of which $100 has been subscribed by A. D. Ferguson, of Fresno, R. L. Patterson and R. W. Dallas, of Coalinga, W. E. and H. H. Dingley, of Lemoore, $20 each.

Hanford, Cal.—With a capital stock of $25,000 the Lemoore Ice and Power Co. has been incorporated here. Shares are to be $1.00 each. H. C. Watson, Gus Merz, W. E. Dingley and others have subscribed $3,625. Lemoore is to be the place of business.

Red Bluff, Cal.—There has been incorporated here the Coneland Water Co., with a capital stock of $100,000, the shares being $1.00 each. The directors in the new concern are G. G. Kenoyer, A. M. Ross, J. E. Widner, P. F. Byrne and Alvin Dunn, all of whom reside in Los Molinos.

Visalia, Cal.—An assessment has been declared by the Lindsay Heights Water Co. which was due February 1st. The sale day has been set as March 9th.

ington. Three units of 10,000 horsepower each will be added at a cost of $250,000. It will take nine months to complete the work.

Tacoma, Wash.—Announcement was made February 20th of the dissolution of the firm of Davis Bros. Electric Co., the firm being absorbed in a new corporation which has just been incorporated under the laws of the State of Washington, with a paid-up capital of $150,000. This means the establishment in Tacoma of the largest electrical fixture manufacturing plant on the Pacific Coast. Marcus C. Davies is president of the new corporation.

## WATER WORKS.

Dinuba, Cal.—A special election has been called by the Town Trustees for March 16 to determine whether an indebtedness of $15,000 shall be incurred by the city for the purpose of acquiring, constructing, managing and repairing pumps and other works necessary and proper for supplying water for municipal purposes.

Phoenix, Ariz.—Phoenix now has money in the bank with which to buy the city water works just as soon as Congress gives permission. Notification has been given by the Phoenix National Bank that it stood ready to honor the check of the city treasurer for any sum not exceeding $240,000, the money being the proceeds of the sale of the city water works bonds to Todd & Co., of Cincinnati.

San Diego, Cal.—Within a few days the work of installing a pumping plant on the block on University Heights in which is located the city reservoir will be started. The work has been ordered by the Board of Public Works and this pumping plant will be used in emergencies to fill the 160,000-gallon tank on block 15, which has been constructed to supply water to residents within a district of twenty blocks.

Oakland, Cal.—The resolution of the city council requesting the People's Water Co., the Oakland Gas, Light and Heat Co. and the telephone companies to lay down conduits, pipes, etc., on East Fourteenth Street from Twenty-fourth Avenue to the eastern boundary of the city, before the beginning of paving on that street, was referred to the city electrician by the board of public works.

Oakland, Cal.—The People's Water Co. is planning an extensive system for piping water to Berkeley which will be adequate for many years to come. An immense well has been sunk in the San Pablo lowlands which will supply the town with 5,000,000 gallons a day. A large dam will be built on San Pablo Creek, which will be built of solid concrete and is to stand 150 feet high. The water from this reservoir will be carried to Berkeley through the hills below Wildcat Canyon.

Suisun, Cal.—A communication has been received by the town trustees from the Suisun Lumber Co. stating that arrangements are being made by the company to install a pumping plant for its own fire protection. It was proposed that if the town would supply about 300 feet of four-inch pipe the company would connect its plant to the town mains and in case it was ever needed could pump water from the slough and give pressure all over town for putting out fires.

Los Angeles, Cal.—Work on the Los Angeles aqueduct will commence on the open cut from the intake of the Owens River to the north end of the Alabama hills, twenty-three miles long. The canal will be dredged with a centrifugal pump and operated by electrical power. Plans for boat and machinery have been made, and bids for supplying the machinery are now being advertised for. The boat or scow upon which the centrifugal pump will be carried will be thirty feet long. It will be built of steel in sections of a size convenient for handling, the estimated cost being $1,100. The dredging machinery consists of a cutter, a centrifugal pump and three motors. Power will be developed from Division Creek for operating the dredge and lighting the works by laying 5,100 feet of twelve-inch pipe and installing a Pelton wheel and the electrical machinery required to furnish 200 horsepower. Engineer Mulholland estimates the total cost of power plant, dredger and lighting at $17,500.

## ILLUMINATION.

Los Angeles, Cal.—A franchise has been granted by the Supervisors to the Pacific Light and Power Company for a pole-and-wire line to Dominguez.

Las Vegas, N. M.—The New Mexico Insane Asylum has been authorized to issue bonds for $105,000 for needed improvements. Among these will be a power house and electric light plant.

Haywards, Cal.—The privilege of laying gas pipes and supplying the streets and buildings of the town with gas for illumination has been granted to the Suburban Electric Light Company of San Leandro.

Los Angeles, Cal.—The City Gas Company is rushing preliminary work preparatory to building a large plant and laying a system of distributing mains. A. Ross, the general manager, has opened an office in the Wilcox building and has received subscriptions to the amount of $1,000,000.

Healdsburg, Cal.—No action was taken at the last meeting of the Town Trustees relative to the granting of a franchise to D. Wickersham for the maintaining of a gas plant in this city. It is expected that the matter will be taken up at a later meeting.

San Francisco, Cal.—The Board of Supervisors has passed the ordinance fixing the water, gas and electric rates for the year. The legal charges will be the same as during the last year, namely, 85 cents per 1000 for gas, 9 cents for 1000 watt-hours for current, with a minimum meter charge of $1 a month.

Campeche, Mexico.—This city, the capital of the State of Campeche, is to have a modern electric light plant. L. B. Spyer & Company, the bankers of the city, have been granted the exclusive privilege for twenty years of furnishing electric light and power for the city of Campeche. The company will soon be incorporated by Mr. Spyer and his associates with a capital stock of $300,000.

Santa Paula, Cal.—At the next meeting of the City Trustees the Ventura County Power Company will present an application for a franchise to lay gas lines through the streets. Hon. Robert M. Clarke is the attorney of the company. It is probable that a special permit will be granted, allowing the company to start work immediately before the necessary time to advertise the sale of the franchise has expired.

Greenville, Cal.—J. C. Young, a merchant and rancher of Taylorsville, is gathering statistics with a view to installing at Taylorsville an electric light plant for the purpose of supplying the entire Indian Valley, including the towns of Greenville, Crescent Mills and Prattville. Recently Mr. Young purchased the milling plant of J. W. Thompson, and with the plant a water right for power purposes. The power consists of about 10,000 inches with a fifteen-foot drop. Mr. Young proposes to organize a stock company.

Eureka, Cal.—Competition is promised for the benefit of Eureka gas consumers. For the last two years there have been two electric lighting companies supplying the town, and the same rivalry is now to be extended to all departments of the illuminating industry. Articles of incorporation have been filed by the Humboldt Gas and Electric Co., which is backed by virtually the same interests that control the North Mountain Power Co. The plant to be erected will be solely for the production of gas. F. J. Koster, one of the prime movers in the enterprise, stated that the aim of the company is to give Eurekans a thoroughly modern and reliable gas system. The gas works will probably be located on property owned by the North Mountain Power Co., adjacent to the auxiliary station in the east end. As to the cost and equipment nothing definite has been decided. The contract for the new works has not been let, but bids will soon be called for. The capital stock has been placed at $1,500,000, and has been divided into 500,000 shares at $3 each. The original subscribers to the stock are Gordon Blanding, John L. Koster, Wm. Carson, Harry P. Vance and Henry Deering, each having taken one share. They also constitute the board of directors for the first year.